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Information technology — Telecommunications and information exchange between systems — High-level data link control (HDLC) procedures — Classes of procedures —

Technologies de l'information — Télécommunications et échange d'informations entre systèmes — Procédures de commande de liaison de données à haut niveau (HDLC) — Classes de procédures

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Contents

Page

Introduction iv

1 Scope 1

2 Normative references 1

3 General description 1

4 Unbalanced operation (point-to-point and multipoint) 6

5 Balanced operation (point-to-point) 9

6 Uses of the optional functions 11

Annex

A Examples of typical HDLC procedural subsets 16

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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.

ISO/IEC 7809 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*.

This second edition cancels and replaces the first edition (ISO 7809 : 1984), which has been technically revised.

Annex A is for information only.

Introduction

High-level data link control (HDLC) classes of procedures describe methods of data link operation which permit synchronous or start/stop, code-transparent data transmission between data stations in a variety of logical and physical configurations. The classes are defined in a consistent manner within the framework of an overall HDLC architecture. One of the purposes of this International Standard is to maintain maximum compatibility between the basic types of procedures, unbalanced and balanced, as this is particularly desirable for data stations with configurable capability, which may have the characteristics of a primary, secondary, or combined station, as required for a specific connection.

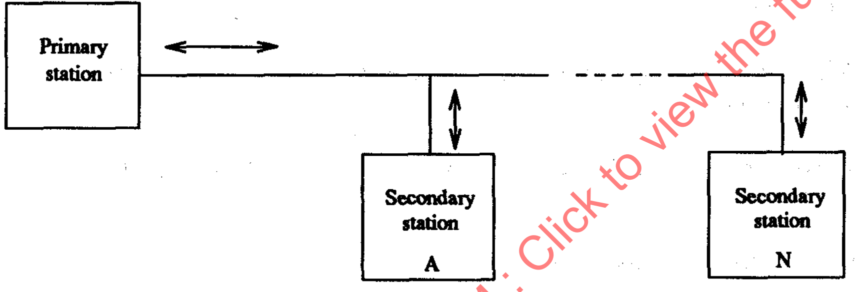


Figure 1 - Unbalanced data link configuration

This International Standard defines three fundamental classes of procedures (two unbalanced and one balanced). The unbalanced classes apply to both point-to-point and multipoint configurations (as illustrated in figure 1) over either dedicated or switched data transmission facilities. A characteristic of the unbalanced classes is the existence of a single primary station at one end of the data link plus one or more secondary stations at the other end(s) of the data link. The primary station alone is responsible for data link management, hence the designation "unbalanced" classes of procedures.

The balanced class applies to point-to-point configurations (as illustrated in figure 2) over either dedicated or switched data transmission facilities. A characteristic of the balanced class is the existence of two data stations, called combined stations, on a logical data link, that may share equally in the responsibility for data link management, hence the designation "balanced" class of procedures.

For each class of procedures, a method of operation is specified in terms of the capabilities of the basic repertoire of commands and responses that are found in that class. A variety of optional functions are also listed. Procedural descriptions for the use of the optional functions are found in clause 6.

It is recognized that it is possible to construct symmetrical configurations for operation on a single data circuit from the unbalanced classes of procedures which are defined in this International Standard. For example, the combination of two unbalanced procedures (with I frame flow as commands only) in opposite directions would create a symmetrical point-to-point configuration (as illustrated in figure 3).

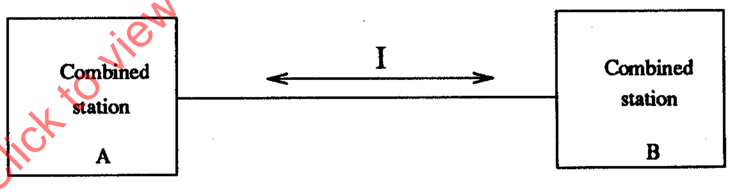


Figure 2 - Balanced data link configuration

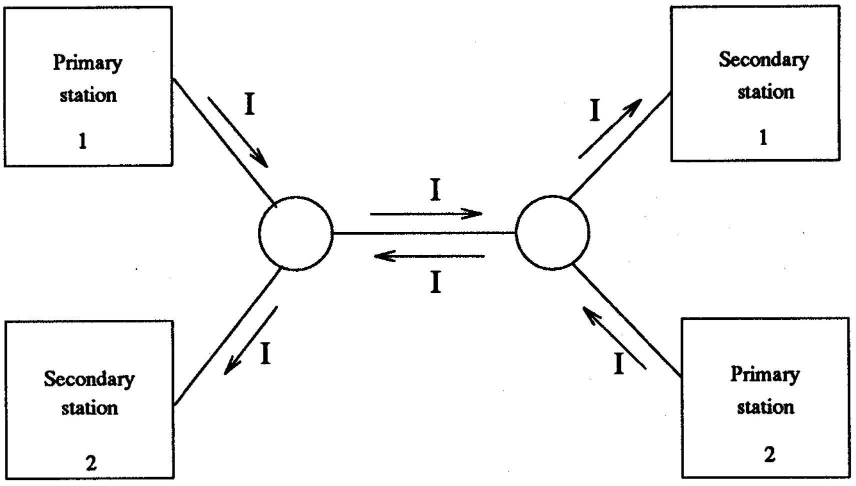


Figure 3 - Symmetrical data link configuration

Information technology — Telecommunications and information exchange between systems — High-level data link control (HDLC) procedures — Classes of procedures

1 Scope

This International Standard describes the HDLC unbalanced classes of procedures and the HDLC balanced class of procedures for synchronous or start/stop data transmission.

Balanced operation is intended for use in circumstances which require equal control at either end of the data link. Operational requirements are covered in accordance with the overall HDLC architecture. The procedures use the HDLC frame structure defined in ISO/IEC 3309 and the HDLC elements of procedures described in ISO/IEC 4335.

For the unbalanced classes, the data link consists of a primary station plus one or more secondary stations and operates in either the normal response mode or the asynchronous response mode in a point-to-point or multipoint configuration. For the balanced class, the data link consists of two combined stations and operates in the asynchronous balanced mode in a point-to-point configuration. In each class, a basic repertoire of commands and responses is defined, but the capability of the data link may be modified by the use of optional functions.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provision 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 indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/IEC 2382-9 : 1984, *Data processing - Vocabulary - Part 09: Data communication.*

ISO/IEC 3309 : 1991, *Information technology - Telecommunications and information exchange between systems - High-level data link control (HDLC) procedures - Frame structure.*

ISO/IEC 4335 : 1991, *Information technology - Telecommunications and information exchange between systems - High level data link control (HDLC) procedures - Elements of procedures.*

ISO/IEC 8885 : 1991, *Information technology - Telecommunications and information exchange between systems - High-level data link control (HDLC) procedures - General purpose XID frame information field content and format.*

3 General description

3.1 Principles

3.1.1 Types of data station

3.1.1.1 Two types of data station are defined for the unbalanced classes of procedures (see figure 4):

a) primary station, which sends commands, receives responses and is ultimately responsible for data link layer error recovery;

b) secondary stations, which receive commands, send responses and may initiate data link layer error recovery.

3.1.1.2 One type of data station is defined for the balanced class of procedures (see figure 4), i.e. combined stations, which send both commands and responses, receive both commands and responses, and are responsible for data link layer error recovery.

3.1.2 Configurations

For the unbalanced classes of procedures, a single primary station plus one or more secondary station(s) shall be connected together over various types of transmission facilities to build point-to-point or multipoint, half-duplex or duplex, switched or non-switched configurations.

For the balanced class of procedures, two combined stations shall be connected together over various types of transmission facilities to build point-to-point, half-duplex or duplex, switched or non-switched configurations.

3.1.3 Operational modes

In an unbalanced class, any coupling of a primary station with secondary station(s) shall be operated in either the normal response mode (NRM) or the asynchronous response mode (ARM), two-way alternate or two-way simultaneous, in accordance with the capability of the configuration being employed. In the balanced class, two combined stations shall be operated in the asynchronous balanced mode (ABM), two-way alternate or two-way simultaneous, in accordance with the capability of the configuration being employed.

3.1.4 Addressing scheme

In all classes (unbalanced and balanced), commands shall always be sent containing a destination data station address, and responses shall always be sent containing the assigned transmitting data station address.

The "all-station" address or a "group" address may be used to transmit a command frame simultaneously to all the secondary stations on a multipoint configuration or to the defined group of secondary stations. The addressing convention is specified in ISO/IEC 3309, clause 5. The mechanism to avoid overlapping responses to multiple station addressing is system dependent and is not specified in either ISO/IEC 3309 or this International Standard.

3.1.5 Send and receive state variables

For each primary-to-secondary or combined-to-combined pairing, a separate pair of send and receive state variables shall be used for each direction of transmission of information (I) frames. Upon receipt and acceptance of a mode setting command, both the send and receive state variables of the receiving station, shall be set to zero. Upon receipt and acceptance of an acknowledgement response to a mode setting command, both the send and receive state variables of the originating station shall be set to zero.

3.2 Fundamental classes of procedures

3.2.1 Designations

Three fundamental classes of procedures are defined. They are designated:

UNC - Unbalanced operation Normal response mode Class;

UAC - Unbalanced operation Asynchronous response mode Class; and

BAC - Balanced operation Asynchronous balanced mode Class.

In these designations

— the first letter, U or B, indicates unbalanced or balanced operation;

— the second letter, A or N, indicates asynchronous or normal response mode; and

— the third letter, C, stands for class.

3.2.2 Basic repertoires

The following basic repertoires utilize single octet addressing, unextended control field format, a 16-bit FCS, and synchronous transmission.

3.2.2.1 UNC

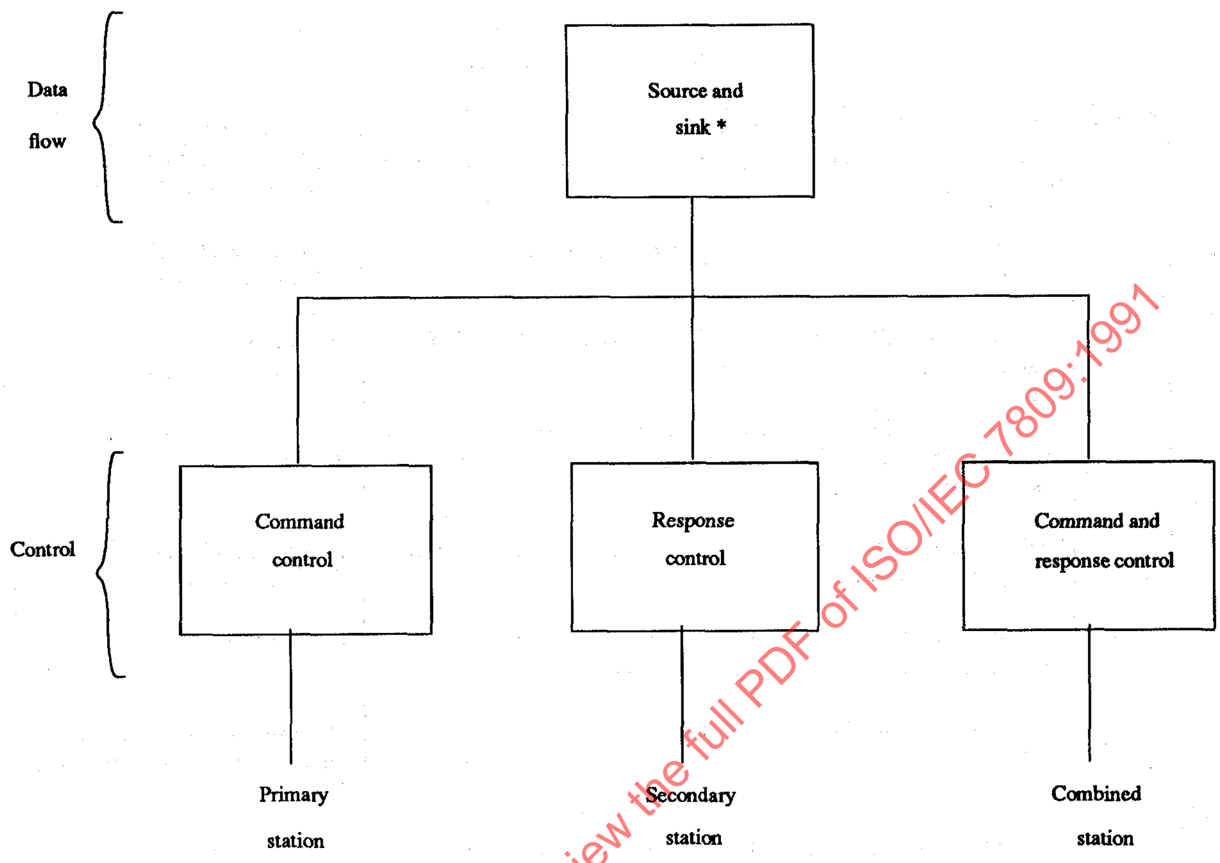
The basic repertoire of commands and responses for UNC shall be as follows:

Commands	Responses
I	I
RR	RR
RNR	RNR
SNRM	UA
DISC	DM
	FRMR

3.2.2.2 UAC

The basic repertoire of commands and responses for UAC shall be as follows:

Commands	Responses
I	I
RR	RR
RNR	RNR
SARM	UA
DISC	DM
	FRMR



* For send-only I frame stations or receive-only I frame stations, remove source or sink capability, as appropriate.

Figure 4 - HDLC stations - Building blocks

3.2.2.3 BAC

The basic repertoire of commands and responses for BAC shall be as follows:

Commands	Responses
I	I
RR	RR
RNR	RNR
SABM	UA
DISC	DM
	FRMR

3.3 Optional functions

Fifteen optional functions are available (see table 1) to modify the fundamental classes of procedures defined in 3.2. These optional functions are obtained by the additions or deletions of commands and responses to or from the basic repertoires, or by the use of alternate address or control field formats or alternate frame checking sequences or alternate form of transmission (see figure 5). Option 11 is applicable to the balanced class of procedures only.

3.4 Consistency of classes of procedures

The consistency in the three classes of procedures, obtained through the use of the concepts of modes of operation, basic command/response repertoires, and hierarchical structuring, is shown in figure 5. This consistency in repertoire facilitates the inclusion of multiple versions of the classes of procedures in a data station that is configurable.

Table 1 - Optional functions

Option	Functional description	Required change
1	Provides the ability to exchange identification and/or characteristics of data stations	Add command: XID Add response: XID
2	Provides the ability for more timely reporting of I frame sequence errors	Add command: REJ Add response: REJ
3	Provides the ability for more efficient recovery from I frame sequence errors by requesting retransmission of a single frame	Add command: SREJ Add response: SREJ
4	Provides the ability to exchange information fields independent of the mode (operational or non-operational) without impacting the I frame sequence numbers	Add command: UI Add response: UI
5	Provides the ability to initialize a remote data station, and the ability to request initialization	Add command: SIM Add response: RIM
6	Provides the ability to perform unnumbered group and all-station polling as well as unnumbered individual polling	Add command: UP
7	Provides for greater than single octet addressing	Use extended addressing format instead of basic addressing format
8	Limits the procedures to allow I frames to be commands only	Delete response: I
9	Limits the procedures to allow I frames to be responses only	Delete command: I
10	Provides the ability to use extended sequence numbering (modulo 128)	Use extended control field format instead of basic control field format. Use SXXME instead of SXXM
11	Provides the ability to reset the state variables associated with only one direction of information flow (for BAC only)	Add command: RSET
12	Provides the ability to perform a basic data link test	Add command: TEST Add response: TEST
13	Provides the ability to request logical disconnection	Add response: RD
14	Provides for 32-bit frame checking sequence (FCS)	Use the 32-bit FCS instead of the 16-bit FCS
15	Provides for start/stop transmission	Use start/stop transmission instead of synchronous transmission

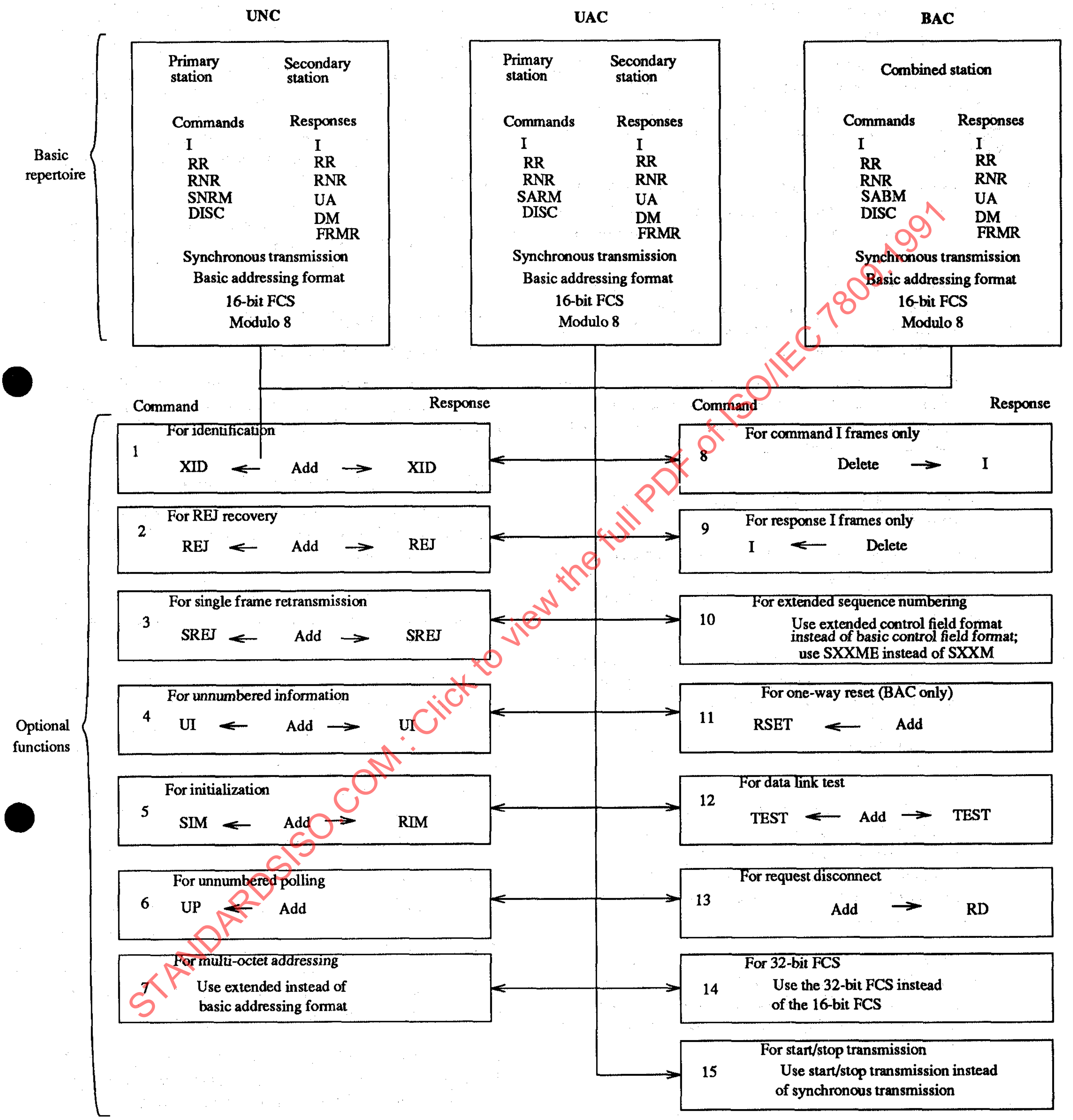


Figure 5 - HDLC classes of procedures

3.5 Conformance to the HDLC classes of procedures

A data station shall be described as conforming to a given class of procedures, with optional functions, if it implements all commands and responses in the basic repertoire for the class of procedures as modified by the selected optional functions, i.e.

a) a primary station shall have the ability to receive all of the responses in the basic repertoire for the unbalanced class of procedures as modified by the selected optional functions;

b) a secondary station shall have the ability to receive all of the commands in the basic repertoire for the unbalanced class of procedures as modified by the selected optional functions;

c) a combined station shall have the ability to receive all of the commands and responses in the basic repertoire for the balanced class of procedures as modified by the selected optional functions.

3.6 Method of indicating classes and optional functions

The classes of procedures and the optional functions shall be indicated by specifying the designation of the class (see 3.2.1) plus the number(s) of the accompanying optional functions (see 3.3).

Example 1: Class UNC1,2,6,9 indicates the unbalanced operation normal response mode class of procedures with the optional function for identification (XID), REJ recovery (REJ), unnumbered polling (UP), and one-way data flow from the secondary station(s) to the primary station.

Example 2: Class UAC1,5,10,13 indicates the unbalanced operation asynchronous response mode class of procedures with the optional functions for identification (XID), initialization (SIM, RIM), extended sequence numbering (modulo 128), and request disconnect (RD).

Example 3: Class BAC2,8 indicates the balanced operation asynchronous balanced mode class of procedures with the optional functions for REJ recovery (REJ) and the ability to send I frames as commands only.

4 Unbalanced operation (point-to-point and multipoint)

4.1 General

The following requirements apply to the procedure for unbalanced operation of synchronous or start/stop data transmission over point-to-point or multipoint data links with two-way alternate or two-way simultaneous data transfer. The procedure uses the HDLC frame structure defined in ISO/IEC 3309 and the HDLC elements of procedures described in ISO/IEC 4335. It uses the basic command/response repertoire (see figure 5) designated UNC (or UAC). Although only the basic commands and responses are described, there are several optional functions available for enhanced operation. These are listed in 3.3 and shown in figure 5.

NOTE — The HDLC unbalanced classes of procedures operate as illustrated in the examples given in ISO/IEC 4335, Annex B. (See clause 1.)

4.2 Description of the data link

4.2.1 Configuration (see figure 1)

The unbalanced operation data link configuration shall consist of one primary station and one or more secondary stations interconnected by physical layer transmission facilities.

4.2.2 Physical layer transmission facilities

The physical layer transmission facilities may provide either half-duplex or duplex transmission over switched or non-switched data circuits.

NOTE — In the case of a switched data circuit, the procedures described assume that the switched data circuit has been established.

The data link layer shall not initiate data transmission until an indication of circuit availability is provided by the physical layer. (In some systems providing two-way alternate data exchange on physical layer data circuits using half-duplex transmission, this indication of physical layer circuit availability is indicated by an idle data link channel state.)

4.3 Description of the procedures

4.3.1 General

Unbalanced control procedures shall operate on a data link with one primary station and one or more secondary station(s) in either normal or asynchronous response mode. Only one secondary station at a time shall be put in asynchronous response mode. The primary station shall be ultimately responsible for overall data link error recovery.

Each data station shall check for the correct receipt of the I frames it has sent to the remote data station by checking the N(R) of each received I frame and supervisory frame.

4.3.2 Data station characteristics

The primary station shall be responsible for:

a) setting up the data link and disconnecting the data link;

b) sending information transfer, supervisory and unnumbered commands; and

c) checking received responses.

Each secondary station shall be responsible for:

a) checking received commands; and

b) sending information transfer, supervisory and unnumbered responses as required by the received commands.

4.4 Detailed definition of the procedures

The procedures for a permanently connected data link or an established switched connection are defined in 4.4.1 to 4.4.6.

The protocol for establishing and disconnecting a switched data circuit is not within the scope of this International Standard. However, the ability to exchange identification and/or characteristics after the switched connection is established is available as an optional function.

4.4.1 Setting up and disconnecting the data link

4.4.1.1 Setting up the data link

The primary station shall initialize the data link with a secondary station by sending a SNRM (or SARM) command and shall start a response time-out function (or equivalent). The addressed secondary station, upon receiving the SNRM (or SARM) command correctly, shall send the UA response at its first opportunity and shall set its send and receive state variables to zero. If the UA response is received correctly, the data link set up to the addressed secondary station is complete, and the primary station shall set its send and receive state variables relative to that secondary station to zero and shall stop the response time-out function (or equivalent). If, upon receipt of the SNRM (or SARM) command, the secondary station determines that it cannot enter the indicated mode, it shall send the DM response. If the DM response is received correctly, the primary station shall stop the response time-out function (or equivalent).

If the SNRM (or SARM) command, UA response or DM response is not received correctly, it shall be ignored. The result will be that the primary station's response time-out function (or equivalent) will run out, and the primary station may resend the SNRM (or SARM) command and restart the response time-out function (or equivalent) (see 4.4.3).

This action may continue until a UA response has been received correctly or until recovery action takes place at a higher level.

4.4.1.2 Disconnecting the data link

The primary station shall disconnect the data link(s) with secondary station(s) by sending a DISC command and shall start a response time-out function (or equivalent). The addressed secondary station(s), upon receiving the DISC command correctly, shall send a UA response at its first opportunity and shall enter the normal disconnect mode (NDM), or the asynchronous disconnected mode (ADM), as predefined for that secondary station. If, upon receipt of the DISC command, the addressed secondary station is already in the disconnected mode, it shall send the DM response. The primary station, upon receiving a UA or DM response to a sent DISC command, shall stop the response time-out function (or equivalent).

When it is a multipoint configuration, the UA response from secondary stations shall not interfere with one another. The mechanism used to avoid overlapping responses to the disconnect (DISC) command using a group address or the all station address is system-defined.

If the DISC command, UA response or DM response is not received correctly, it shall be ignored by the receiving station. This will result in the expiry of the primary station's response time-out function (or equivalent), and the primary station may resend the DISC command and restart the response time-out function (or equivalent) (see 4.4.3).

This action may continue until either the UA response or a DM response has been received correctly or until recovery action takes place at a higher level.

4.4.1.3 Procedure in a disconnected mode

A secondary station in NDM (or ADM) shall monitor commands, shall react, at the earliest respond opportunity, to a SNRM (or SARM) command as outlined in 4.4.1.1, and shall respond with a DM response to a received DISC command. The secondary station shall respond to other commands received with the P bit set to "1" with a disconnected mode (DM) response with the F bit set to "1". Other commands received with the P bit set to "0" shall be ignored. The DM response shall be used to report the secondary station status asynchronously in ADM.

4.4.2 Exchange of information (I) frames

4.4.2.1 Sending I frames

The control field format shall be as defined in ISO/IEC 4335 (see clause 1) for an I frame with N(S) set to the value of the send state variable V(S) and with N(R) set to the value of the receive state variable V(R). Following data link set-up, both V(S) and V(R) shall be set to zero. The maximum length of I frames shall be a system-defined parameter.

If the data station is ready to send an I frame numbered N(S), where N(S) is equal to the last received acknowledgement plus the modulo - 1, the data station shall not send the I frame but shall follow the procedures described in 4.4.3.

4.4.2.2 Receiving I frames

After a data station receives correctly an in-sequence I frame [i.e., N(S) equals the value of the receive state variable V(R)] that it can accept, it shall increment its receive state variable V(R), and, at its next opportunity to send, take one of the following actions:

a) If information is available for transmission and the remote data station is ready to receive, it shall act as described in 4.4.2.1 and acknowledge the received I frame(s) by setting N(R) in the control field of the next transmitted I frame to the value of V(R).

b) If information is not available for transmission but the data station is ready to receive I frames, the data station shall send an RR frame and acknowledge the received I frame(s) by setting N(R) to the value of V(R).

c) If the data station is not ready to receive further I frames, the data station may send an RNR frame and acknowledge the received I frame(s) by setting the N(R) to the value of V(R).

If the data station is unable to accept the correctly received I frame(s), V(R) shall not be incremented. The data station may send an RNR frame with the N(R) set to the value of V(R).

4.4.2.3 Reception of incorrect frames

If a frame is received with an incorrect FCS, it shall be discarded.

If an I frame is received with a correct FCS but with an incorrect N(S), the receiving data station shall ignore the N(S) field and discard the information field in that frame. This shall continue until the expected I frame is received correctly. The data station shall, however, use the P/F and N(R) indications in the discarded I frames. The data station shall then acknowledge the expected I frame, when received correctly, as described in 4.4.2.2.

The P/F recovery (checkpointing) shall cause retransmission of the I frames received incorrectly, as described in 4.4.4.

4.4.2.4 Data station receiving acknowledgments

A data station receiving an I, RR or RNR frame with a valid N(R) = *x* shall treat as acknowledged all previously transmitted I frames up to and including the I frame transmitted with N(S) equal to *x* - 1.

4.4.3 Time-out considerations

In order to detect a non-reply or lost-reply condition, each primary station shall provide a response time-out function (or equivalent). Also, in ARM, each secondary station shall provide a command time-out function (or equivalent). In each case, the expiry of the time-out function (or equivalent) shall be used to initiate appropriate error recovery procedures.

In NRM, a secondary station shall depend on the primary station to initiate time-out recovery.

The duration of time-out functions (or equivalent) shall be system-dependent and subject to bilateral agreement. To resolve possible contention situations in ARM, the duration of the secondary station's time-out function shall be different from that of the primary station.

4.4.4 P/F bit usage

P/F bit usage in the unbalanced classes of procedures, UNC and UAC, shall be as described in ISO/IEC 4335.

4.4.5 Two-way alternate considerations

In the case of normal respond opportunity, two-way alternate, data link operation

a) transmission from the primary station shall not be allowed until either

1) receipt of a frame with the F bit set to "1", or

2) expiry of a no-response time-out function; and

b) transmission from the secondary station shall not be allowed until receipt of a frame with the P bit set to "1".

NOTE 1 — In multipoint configurations of normal respond opportunity, two-way alternate, data link operation over duplex physical facilities, the primary station may transmit frames with the P bit set to "0" to non-polled secondary stations in the above mentioned period.

In the case of normal respond opportunity, two-way alternate, data link operation, a data station shall not accept further frames after a frame with the P/F bit set to "1" was accepted and before it sends a frame with the F/P bit, respectively, set to "1".

In the case of asynchronous respond opportunity, two-way alternate, data link operation, transmission from a data station shall not be allowed until either

a) detection of an idle data link channel state after receipt of a frame or a flag; or

b) the end of an extended period of inactivity (idle data link channel state).

NOTE 2 — In the case of half-duplex data circuit facilities, appropriate accommodation has to be made to control the direction of data transmission. The direction of transmission is controlled by the data link layer, and may be signalled by the physical layer.

If no frames are transmitted from either data station while in ARM and information is waiting for transmission, it is advisable that the data station transmits at first a supervisory frame only in order to avoid long time recovery action, which would occur in the case of I frame contention.

If a data station has transmitted frames and no further frames are pending for transmission, it shall give the right to transmit to the remote data station.

4.4.6 Two-way simultaneous considerations

For each unbalanced class of procedures, two-way simultaneous communication protocols may be used independent of physical data circuit capability (i.e. half-duplex transmission). However, in the case of half-duplex data circuit facilities, appropriate accommodate has to be made to control the direction of data transmission. The direction of transmission is controlled by the data link layer. In addition, in the case of normal respond opportunity, data transmission from the secondary station shall not be allowed until receipt of a frame with the P bit set to "1".

5 Balanced operation (point-to-point)

5.1 General

The following requirements apply to the procedure for balanced operation of synchronous or start/stop data transmission over point-to-point data links with two-way alternate or two-way simultaneous data transfer. The procedure uses the HDLC frame structure defined in ISO/IEC 3309 and the HDLC elements of procedures described in ISO/IEC 4335.

It uses the basic command/response repertoire (see figure 5) designated BAC. Although only the basic commands and responses are described, there are several optional functions available for enhanced operation. These are listed in 3.3 and shown in figure 5.

NOTE — The HDLC balanced class of procedures operates as illustrated in the examples given in ISO/IEC 4335, Annex B. (See clause 1.)

5.2 Description of the data link

5.2.1 Configuration (see figure 2)

The balanced operation data link configuration shall consist of two combined stations interconnected by physical layer transmission facilities.

5.2.2 Physical layer transmission facilities

The physical layer transmission facilities may provide either half-duplex or duplex transmission over switched or non-switched data circuits.

NOTE — In the case of a switched data circuit, the procedures described assume that the switched data circuit has been established.

The data link layer shall not initiate data transmission until an indication of circuit availability is provided by the physical layer. (In some systems providing two-way alternate data exchange on physical layer data circuits using half-duplex transmission, this indication of physical layer circuit availability is indicated by an idle data link channel state.)

5.3 Description of the procedures

5.3.1 General

Balanced control procedures shall operate on a data link where the data station at each end of the data link is a combined station. The procedures shall use the asynchronous balanced mode. Each combined station shall be equally responsible for data link layer error recovery.

Each combined station shall check for the correct receipt of the I frames it has sent to the remote combined station by checking the N(R) of each received I frame or supervisory frame.

5.3.2 Combined station characteristics

Each station shall be a combined station, i.e., it shall be able to set up the data link, disconnect the data link, and both send and receive commands and responses.

5.4 Detailed definition of the procedures

The procedures for a point-to-point data link using a permanently connected or an established switched connection are defined in 5.4.1 to 5.4.6.

The protocol for establishing and disconnecting a switched data circuit is not within the scope of this International Standard. However, the ability to exchange identification and/or characteristics after the switched connection is established is available as an optional function.

5.4.1 Setting up and disconnecting the data link

5.4.1.1 Setting up the data link

Either combined station may take the initiative to initialize the data link. It shall send the SABM command and start a response time-out function (or equivalent). The other combined station, upon receiving the SABM command correctly, shall send a UA response and reset both its send and receive state variables to zero. If the UA response is received correctly, the data link set-up shall be complete, and the initiating combined station shall set both its state variables to zero, stop the response time-out function (or equivalent), and enter the indicated mode. If, upon receipt of the SABM command, a combined station determines that it can not enter the indicated mode, it shall send the DM response. If the DM response is received correctly, the initiating combined station shall stop the response time-out function (or equivalent).

If an SABM command, UA response or DM response is not received correctly, it shall be ignored. The result will be that the response time-out function (or equivalent) will run out in the combined station which originally sent the SABM command and that combined station may resend the SABM command and restart the response time-out function (or equivalent) (see 5.4.3).

This action may continue until a UA response has been received correctly or until recovery action takes place at a higher layer.

5.4.1.2 Disconnecting the data link

Either combined station may take the initiative to disconnect the data link. It shall send the DISC command and start a response time-out function (or equivalent). The other combined station, in an operational mode, upon receiving the DISC command correctly, shall send a UA response and enter the asynchronous disconnected mode (ADM). If, upon receipt of the DISC command, the other combined station is already in the disconnected mode, it shall send the DM response. The initiating combined station, on receiving a UA or DM response to a sent DISC command, shall stop its response time-out function (or equivalent).

If a DISC command, UA response or DM response is not received correctly, it shall be ignored. The result will be that the response time-out function (or equivalent) will run out in the combined station which originally sent the DISC command unless a separate mode setting command is received, in which case the response time-out function (or equivalent) may be stopped. This combined station may resend the DISC command and restart its response time-out function (or equivalent).

This action may continue until a UA or DM response has been received correctly, a DISC command has been received correctly, or until recovery action takes place at a higher layer.

5.4.1.3 Procedure in a disconnected mode

A combined station in ADM shall monitor received commands, shall react to a SABM command as outlined in 5.4.1.1, and shall respond with a DM response to a received DISC command. It shall respond to other commands received with the P bit set to "1" with a disconnected mode (DM) response with the F bit set to "1". Other commands received with the P bit set to "0" shall be ignored. The DM response shall be used to report the combined station status asynchronously in ADM.

5.4.1.4 Simultaneous attempts to set mode (contention)

When a combined station issues a mode setting command and, before receiving an appropriate response, receives a mode setting command from the remote combined station, a contention situation has developed. Contention situations shall be resolved in the following manner.

When the sent and received mode setting commands are the same, each combined station shall send a UA response at the earliest respond opportunity. Each combined station shall either enter the indicated mode immediately or defer entering the indicated mode until receiving a UA response. In the latter case, if the UA response is not received, the combined station may enter the mode when the response time-out function (or equivalent) expires, or the combined station may reissue the mode setting command.

When the mode setting commands are different, each combined station shall enter ADM and issue a DM response at the earliest respond opportunity. In the case of a DISC command contention with a different mode setting command, no further action is required. In the case of contention between SABM and SABME commands, the combined station sending the SABME command shall have priority over the combined station sending the SABM command in re-attempting data link establishment.

5.4.2 Exchange of information (I) frames

5.4.2.1 Sending I frames

The control field format shall be as defined in ISO/IEC 4335 (see clause 1) for an I frame, with N(S) set to the value of the send state variable V(S) and with N(R) set to the value of the receive state variable V(R). Following data link set-up, both V(S) and V(R) shall be set to zero. The maximum length of I frames shall be a system-defined parameter.

If the combined station is ready to send an I frame numbered N(S), where N(S) is equal to the last received acknowledgement plus the modulo - 1, the combined station shall not send the I frame but shall follow the procedures described in 5.4.3.

The decision whether to send an I frame as a command or as a response, i.e., to use the remote or the local address to indicate a P or an F bit, respectively, shall depend on the need to acknowledge a received P bit set to "1" by transmitting a response with the F bit set to "1".

5.4.2.2 Receiving I frames

After a combined station receives correctly an in-sequence I frame [i.e., N(S) equals the value of the receive state variable V(R)] that it can accept, the combined station shall increment its receive state variable V(R), and, at its next opportunity to send, take one of the following actions:

a) if information is available for transmission and the remote combined station is ready to receive, it shall act as described in 5.4.2.1 and acknowledge the received I frame(s) by setting N(R) in the control field of the next transmitted I frame to the value of V(R);

b) if information is not available for transmission, but the combined station is ready to receive I frames, the combined station shall send an RR frame and acknowledge the received I frame(s) by setting N(R) to the value of V(R); or

c) if the combined station is not ready to receive further I frames, the combined station may send an RNR frame and acknowledge the received I frame(s) by setting the N(R) to the value of V(R).

If the combined station is unable to accept the correctly received I frame(s), V(R) shall not be incremented. The combined station may send an RNR frame with the N(R) set to the value of V(R).

The I or supervisory frame transmitted will be either a command or a response depending on whether a P bit set to "1" or an F bit set to "1" transmission, respectively, is required. If the transmission of a P bit or F bit set to "1" is not required, the acknowledgement frames may be either commands or responses.

5.4.2.3 Reception of incorrect frames

If a frame is received with an incorrect FCS, it shall be discarded.

If an I frame is received with a correct FCS but with an incorrect N(S), the receiving combined station shall ignore the N(S) field and discard the information field in that frame. This shall continue until the expected I frame is received correctly. The combined station shall, however, use the P/F and N(R) indications in the discarded I frames. The combined station shall then acknowledge the expected I frame, when received correctly, as described in 5.4.2.2.

The P/F recovery (checkpointing) shall cause the retransmission of the I frames received incorrectly, as described in 5.4.4.

5.4.2.4 Combined station receiving acknowledgements

A combined station receiving an I, RR, or RNR frame with a valid $N(R) = x$ shall treat as acknowledged all previously transmitted I frames up to and including the I frame transmitted with N(S) equal to $x - 1$.

5.4.3 Time-out considerations

In order to detect a no-reply or lost-reply condition, each combined station shall provide a response time-out function (or equivalent). The expiry of the time-out function (or equivalent) shall be used to initiate appropriate error recovery procedures.

The duration of time-out functions (or equivalent) shall be system-dependent and subject to bilateral agreement. The duration of the time-out function (or equivalent) in the two combined stations shall be unequal in order to resolve contention situations, especially in two-way alternate operation.

The time-out function (or equivalent) shall be started whenever the combined station are transmitted a frame for which a reply is required. When the expected reply is received, the time-out function (or equivalent) shall be stopped. If, during the interval that the time-out function (or equivalent) is running, other frames are sent for which acknowledgements are required, the time-out function (or equivalent) may have to be restarted.

If the response time-out function (or equivalent) runs out, a command with the P bit set to "1" may be (re)transmitted, and the response time-out function (or equivalent) restarted.

5.4.4 P/F bit usage

P/F bit usage in the balanced class of procedure, BAC, shall be as described in ISO/IEC 4335 (see clause 1).

5.4.5 Two-way alternate considerations

In two-way alternate, data link operation, transmission from a combined station shall not be allowed until either

a) detection of an idle data link channel state after receipt of a frame or a flag; or

b) the end of an extended period of inactivity (idle data link channel state).

NOTE — In the case of half-duplex data circuit facilities, appropriate accommodation has to be made to control the direction of data transmission. The direction of transmission is controlled by the data link layer, and may be signalled by the physical layer.

If no frames were transmitted from either combined station while in ABM and information is waiting for transmission, it is advisable that the combined station transmits at first a supervisory frame only in order to avoid long time recovery action, which would occur in the case of I frame contention.

If a combined station has transmitted frames and no further frames are pending for transmission, it shall give the right to transmit to the remote combined station.

5.4.6 Two-way simultaneous consideration

For a balanced class of procedures, two-way simultaneous communication protocols, may be used independent of physical data circuit capability (i.e. half-duplex or duplex transmission). However, in the case of half-duplex data circuit facilities, appropriate accommodation has to be made to control the direction of data transmission. The direction of transmission in controlled by the data link layer.

6 Uses of the optional functions

Some uses of the optional functions defined in 3.3 are described in this clause. The optional functions provide additional capabilities beyond the basic operations described in clauses 4 and 5. The commands and responses identified are, in general, defined in ISO/IEC 4335.

6.1 Option 1 — identification

The identification optional function provides the means for data link layer entities to exchange data link layer parameters and characteristics of operation before or during normal operation. The function utilizes the Exchange Identification (XID) command and response frames.

A prime application of Option 1 is in conjunction with a switched network connection. Following the indication of a working physical path from the physical layer, and prior to establishing a logical data link connection over which network layer information can be exchanged, the data link layer entities can exchange details concerning the data link layer addresses (individual and group) that they are responsive to, the capabilities that they support (for example options, class(es) of procedure, etc.), and the parameter values employed (for example, value of reply timer, receive window size, maximum frame length, etc.). The manner in which these details are encoded in the information field of the XID frames exchanged is the subject of ISO/IEC 8885.

Included in the identification function is an option for accommodating a limited amount of higher layer information in the XID frame information field. This may be useful in applications where security and/or authentication check routines must be invoked prior to the establishment of a logical data link connection between network layer entities. Such information is transported transparently by the data link layer entities.

In addition to its applicability before data link connection establishment, the identification function also provides a mechanism for indicating a change in data link layer parameter value(s) while in the information transfer phase. Examples of such parameters are the receive window size and the maximum frame length. Local conditions at one end of a data link connection (for example, long term congestion or non-temporary reduction in buffering capacity) may dictate a change in operation of the remote station in order to maintain efficient utilization of the physical facilities. The identification function allows a local-to-remote transfer of local parameter values at any time, with a remote-to-local confirmation in return.

6.2 Option 2 — REJ recovery

The REJ recovery optional function provides a mechanism for reporting an observed out-of-sequence exception condition of received I frames, and thereby requesting the retransmission of I frames starting with the first missing I frame. The mechanism is the reject (REJ) command/response frame.

This function has its greatest utility in systems that support two-way simultaneous operation, so that an observed gap in received sequence numbers can be reported immediately, during incoming information transfer. In two-way alternate operation, the REJ function offers a somewhat lesser utility, but does separate the sequence error reporting from the P/F bit exchange checkpointing function that in some modes of operation is required to be associated with the last frame transmitted in each transmit opportunity.

In two-way simultaneous operation, the improvement in performance gained by using the REJ function is measured by the number of I frames that would be sent after the point in time where the gap is reported, versus when the transmitter's transmit window is exhausted or acknowledgement timer times-out, and the status enquiry process performed. In cases of large transmit windows or long acknowledgement timers, this could be a substantial amount of time.

6.3 Option 3 — single frame retransmission

The single frame retransmission optional function provides a mechanism for a receiver to request retransmission of a single I frame out of a series of I frames. Any number of requests for different I frames may be outstanding at a time. The mechanism is the selective reject (SREJ) command/response frame.

The SREJ frame does not incorporate an acknowledgement function for I frames received when the P/F bit is set to "0"; it does when the P/F bit is set to "1". For example, to report frames numbered X, X+3, and X+5 missing, a SREJ(X) frame could be sent with its P/F set to "1", when appropriate for the mode of operation, to acknowledge receipt of I frames numbered up through X-1. SREJ(X+3) and SREJ(X+5) frames could be sent immediately with their P/F bits set to "0", not acknowledging any I frames received. Acknowledging receipt of a retransmitted I frame is usually accomplished by an I, RR or RNR frame transmission with an N(R) value that identifies the correct receipt of the requested I frame.

This optional function is equally adaptable to both two-way simultaneous operation and two-way alternate operation. In two-way simultaneous operation, the retransmitted I frames are interspersed in the ongoing sequential transmission of new I frames. In two-way alternate operation, the requested I frames alone are retransmitted, followed by new I frames as appropriate. Although this optional function imposes greater buffering requirements in the receiver data link layer to hold out-of-sequence, higher-numbered good frames received until the required lower-numbered frames are received, it yields a better utility of the information transfer capacity of the data link.

Another request for retransmission can take place when it is perceived that the desired action has not taken place. This perception comes about either as the result of a SREJ timer timeout, or by the receipt of requested I frame X before requested I frame *X* - *n* (the request for I frame *X* - *n* precedes the request for I frame X).

6.4 Option 4 — unnumbered information

The unnumbered information optional function provides a mechanism for the sending of higher layer information at any time without any impact on whatever mode of operation may be in use. The mechanism is the unnumbered information (UI) command/response frame.

There are no logical exchange procedures associated with this function. There are no error recovery procedures, no flow control procedures, no data link establishment procedures, and no acknowledgement procedures associated with UI frame operation. Error control procedures cover only those matters concerned with frame structure and the frame check sequence, leading to the frame being discarded and no action taken. The only data link layer parameter that is involved is the maximum established frame size at the receiver. Violation of maximum frame size will lead to a frame rejection (FRMR) exception condition when received during an information transfer phase.

UI frames can be transmitted to one or more or all multiple stations without concern for sequence number alignment at the stations involved. Depending on the application, UI frames can be transmitted repeatedly with the same contents to improve the likelihood that a good copy of the transmittal is received correctly at all intended receivers.

UI frame-only operation may be a logical choice of operation in highly reliable, error-free data link layer environments. Higher layer provision of error recovery procedures and flow control procedures may result in an acceptable information transport mechanism for the users of such configurations.

6.5 Option 5 — initialization

The initialization optional function provides the mechanisms for requesting and initiating an initialization mode of operation wherein system-defined initialization procedures are utilized. The mechanisms are the set initialization mode (SIM) command and the request initialization mode (RIM) response frames.

This function can be employed at any time, whenever it is deemed necessary by the station involved. A RIM response would result in an SIM command being sent. The SIM command shall be responded to using the UA response frame. The nature and make-up of the exchange or exchanges involved to realize a successful initialization are system defined. The conclusion of the initialization mode is identified by the exchange of an appropriate mode-setting command frame and the UA response frame. When a primary/combined station initiates the initialization procedures, a SIM command frame is sent without there being a requesting RIM response frame.

6.6 Option 6 — unnumbered polling

The unnumbered polling optional function provides the mechanism for a primary/combined station to poll one or more or all of the associated secondary/combined stations with a single frame transmission. The mechanism is the unnumbered poll (UP) command frame.

The UP command frame contains no sequence numbers, acknowledges no frames received and is addressable to one or more or all of the stations on the data link. The order of response and ensuring non-overlap of responses is not the subject of this International Standard. Responses are optional or mandatory depending on whether the UP command frame had its P bit set to "0" or "1", respectively. Unless the underlying response-ordering-mechanism provides an indicator of "last responder", it is suggested that a specified "last" station respond to every UP command frame received, with an F bit set to the value of the P bit in the UP command frame, so that the station which sent the UP command does not have to reply on time-out.

6.7 Option 7 — multi-octet addressing

The multi-octet addressing optional function defines the means for having an address field of N octets in length. The mechanism employs one bit per octet to act as an end-of-address-field indicator. This bit set to "0" means that another address field octet follows. This bit set to "1" means that this octet is the final octet in the address field. The sum of the 7N bits in the identified N-octet address field constitutes a single address. This address can be an individual or group address. The all-station address is always an address octet of "1" bits. An N-octet address field can be considered to have an address that is expressed as a bit stream of 7N bits, or as an N-character series, for instance, using the ISO 646 character set.

This optional function may be employed in situations where it is considered desirable for each data link location within a system (even a system that spans independent data links) to have a unique data link layer identifier. System management and station administration may benefit as a result. Station portability from data link to data link within the system could be enhanced. This optional function may also be employed in situations where one octet of addressing (i.e., 256 total addresses, including the null and the all-station addresses) is insufficient.

6.8 Option 8 — command I frames only

The command I frames only optional function restricts I frames to being I command frames only.

In balanced operation, each combined station's ability to send I frames is only impeded to the extent that an I response frame cannot be utilized to return an F bit set to "1" when an F bit set to "1" must be sent. A non-I response frame must be utilized. If a series of I command frames is in the process of transmission when an F bit set to "1" must be sent, a non-I response frame must be inserted into the stream of I frames, between I frames, in order to convey the F bit set to "1" to the remote station.

In unbalanced operation, applying the optional function results in a quite different overall service, one that yields an information send-only service at the primary station and an information receive-only service at the secondary station(s).

6.9 Option 9 — response I frames only

The response I frames only optional function restricts I frames to being I response frames only. This function was defined to be the procedural complement of the command I frames only optional function (see 6.8).

In balanced operation, each combined station's ability to send I frames is only impeded to the extent that I frames cannot carry P bits. Hence, a non-I command frame must be sent if a P bit set to "1" is required. If a series of I response frames is in the process of transmission when a P bit set to "1" must be sent, a non-I command frame must be inserted into the stream of I frames, between I frames, in order to convey the P bit set to "1" to the remote station.

In unbalanced operation, applying the optional function results in a quite different overall service, one that yields an information receive-only service at the primary station and an information send-only service at the secondary station(s).

6.10 Option 10 — extended sequence numbering

The extended sequence numbering optional function provides the mechanism for defining the sequence numbering for I frame transfer to be modulo 128. The mechanism is in the form of separate mode-setting commands and different frame formats for extended sequence numbering for the normal response mode (NRM) operation, the asynchronous response mode (ARM) operation, and the asynchronous balanced mode (ABM) operation.

The send and receive sequence numbers in I frames are modulo 128. The receive sequence number in supervisory frames is module 128. The control field in I frames and supervisory frames is extended to two octets in length. The control field in unnumbered frames remains one octet in length.

Typical applications for modulo 128 sequence numbers are: satellite operations, long propagation delay environments and very high speed/heavy traffic load situations. The greater modulo value allows for larger send and receive windows to be defined so that information transfer performance can be improved in such applications.

6.11 Option 11 — one-way reset (BAC only)

The one-way reset optional function provides a mechanism for initiating the resetting of the logical data link for one direction of information transfer in the balanced mode of operation without affecting the logical data link for the other direction of information transfer. The mechanism is the reset (RSET) command frame.

A combined station initiates a reset of the logical data link relative to its I frame transmission by sending the RSET command frame. The remote station acknowledges the RSET command frame by returning a UA response frame.

Resetting one direction of the logical data link results in the following events taking place at the RSET sender and the UA sender. The send state variable is reset at the RSET sender, and the receive state variable is reset at the UA sender. The retransmission counter is reset at the RSET sender. The UA response indicates that any busy condition that existed at the UA sender has been cleared. Also, any frame reject (FRMR) condition that existed at the UA sender has been cleared.

6.12 Option 12 — data link test

The data link test optional function provides a mechanism for testing the basic data link layer function at a remote station, at any time, independent of the mode of operation or the phase of the procedures. The mechanism is the test (TEST) command and response frames. It is not intended as a conclusive test of remote station operation.

The test function checks the following capabilities at the remote station:

— detect an opening flag;

— remove zero bits that have been inserted for transparency from the received bit stream following the opening flag;

— detect a closing flag;

— calculate an FCS for the received bit stream;

— check that the unique FCS remainer was obtained;

— decode its address as being the contents of the address field;

— decode the control field as the TEST command;

— accommodate the length of the information field;

— generate a bit stream consisting of its own address in the address field, the TEST response encoding in the control field with the F bit set to the same value as the P bit in the received TEST command control field, and the information received in the information field;

— send an opening flag;

— insert zero bits into the transmitted bit stream following the opening flag so that a flag sequence is not simulated before the closing flag is sent;

— calculate an FCS on the transmitted bit stream (consisting of the address, control and information fields) and append it to the transmitted bit stream for zero bit insertion; and

— end the transmission with a closing flag.

6.13 Option 13 — request disconnect

The request disconnect optional function provides a mechanism for a secondary/combined station to request that a data link disconnect be initiated by a primary/combined station. The mechanism is the request disconnect (RD) response frame.

At an appropriate respond opportunity, a secondary/combined station may send a RD response frame to indicate to the primary/combined station that the secondary/combined station wishes to be placed in the disconnected mode (NDM or ADM). Upon receipt of the RD response frame, the primary/combined station may

a) ignore the RD response frame and continue with the normal procedures; or

b) accept the RD response and issue a DISC command frame.

6.14 Option 14 — 32-bit FCS

The 32-bit FCS optional function provides a higher degree of transmission error detection capability than that available with the normal 16-bit FCS capability. The generator polynomial and the FCS generation and checking process are described in ISO/IEC 3309.

Use of this optional function is determined by prior agreement. Means are not provided in this International Standard for dynamically changing from the use of a 16-bit FCS or a 32-bit FCS to a 32-bit FCS or a 16-bit FCS, respectively.

6.15 Option 15 — start/stop transmission

The start/stop transmission optional function permits HDLC frames and procedures to be used in start/stop transmission environments. The mechanism for start/stop transmission is described in ISO/IEC 3309. Use of this optional function is determined by prior agreement.

Annex A
(informative)

Examples of typical HDLC procedural subsets

A.1 Introduction

The HDLC procedures are designed to cover a wide range of applications (for example, two-way alternate [TWA], two-way simultaneous [TWS] data communication between computers, concentrators and terminals) and a wide range of configuration (for example, multipoint or point-to-point, switched or non-switched, half-duplex or duplex).

International Standards dealing with HDLC define a number of necessary characteristics, including frame formats, operational modes, commands, responses and exception recovery techniques. These functions, used in various combinations, provide the full range of capabilities included in HDLC.

The majority of HDLC implementations will not require the full range of capabilities provided by these International Standards. Therefore, this annex describes several typical subsets of the HDLC procedures to provide uniform HDLC implementations intended to meet the majority of applications required in the immediate future. Use of these suggested typical subsets will help to promote interoperability among independent HDLC implementations designed to satisfy similar operational requirements.

Other procedural subsets may be chosen to meet new or additional requirements provided that they conform to the classes defined in this International Standard.

A.2 Selection parameters

In order to define these typical HDLC procedural subsets, the following application parameters have been considered:

— data communication (TWA, TWS); and

— configuration [point-to-point (pt-pt), multipoint (mpt)].

From these parameters, three typical procedural subsets have been selected as examples and are summarized in table 2.

The optional functions 2, 8 and 10 are recapitulated in table 3 (see also table 1).

Table A.1 - Typical HDLC procedural subsets

Parameters		Typical HDLC procedural subsets	
Data communication	Configuration	No.	Definition
TWA	mpt/pt-pt[1)]	1	UNC
TWS	mpt/pt-pt[1)]	2	UNC 2
	pt-pt	3	BAC 2,8[2)]

NOTES

1 Point-to-point may be viewed as a specific multipoint configuration.

2 BAC 2,8,10 is recommended in some cases (see 5.3.2).