International Standard 4335

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Data communication — High level data link control procedures — Elements of procedures

Téléinformatique — Procédures de commande de liaison de données à haut niveau — Éléments de procédure

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Descriptors : data processing, data transmission, control procedures, high-level data link control.

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FOREWORD

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4335 was developed by Technical Committee ISO/TC 97, *Computers and information processing*, and was circulated to the member bodies in September 1976.

It has been approved by the member bodies of the following countries :

Australia	Italy	Sweden
Belgium	Japan	Switzerland
Canada	Mexico	Turkey
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Finland	Poland	USSR
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No member body expressed disapproval of the document.

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Data communication — High level data link control procedures — Elements of procedures

ADDENDUM 1

Addendum 1 to International Standard ISO 4335-1979 was developed by Technical Committee ISO/TC 97, *Computers and information processing*, and was circulated to the member bodies in June 1978.

It has been approved by the member bodies of the following countries :

Australia	Hungary	South Africa, Rep. of
Belgium	Italy	Spain
Canada	Japan	Sweden
Egypt, Arab Rep. of	Mexico	Switzerland
Finland	Netherlands	United Kingdom
France	Poland	USA
Germany, F. R.	Romania	Yugoslavia

No member body expressed disapproval of the document.

This addendum contains elements of procedures to be added to those already standardized in ISO 4335. It also contains some of the changes to be made to the text of ISO 4335 as a result of adopting these new elements.

The intention of this addendum is to standardize these new elements without the need to update ISO 4335 at this time. When ISO 4335 is eventually revised, the contents of this addendum will be incorporated into the new document.

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1 Definition of NDM, ADM and IM secondary modes

1.1 Disconnected modes

There are two link level disconnected modes : normal disconnected mode (NDM) and asynchronous disconnected mode (ADM). These modes differ from NRM[1] and ARM in that the secondary is logically disconnected from the data link, i.e. no information (I), unnumbered information (UI) or supervisory frames are transmitted or accepted.

These disconnected modes are provided to prevent a secondary from appearing on the link in a fully operational mode during unusual situations or exception conditions since such operation could cause :

— unintended contention in ARM;

— sequence number mismatch between the primary and secondary;

— ambiguity in the primary as to the secondary status.

A secondary shall be system predefined for the condition(s) that cause(s) it always to assume one of the two predetermined disconnected modes (NDM or ADM).

The secondary capability in either NDM or ADM shall be limited to :

— accepting one of the mode setting commands (SNRM, SARM, SNRME, SARME, SIM or DISC);

— accepting an XID command;

— transmitting a DM, XID, RIM or RD response frame at each respond opportunity.

In NDM or ADM, a secondary station, as a minimum capability, shall respond DM with the F bits set to "1" to a command frame received with the P-bit set to "1".

A secondary in NDM or ADM shall not establish a "command reject" exception condition.

If a secondary is in NDM or ADM and receives a DISC command, it shall respond with the DM response. If the secondary is in NRM, ARM or IM and receives a DISC command, it shall respond with the UA response if it is capable of actioning the command.

Examples of possible conditions (in addition to receiving a DISC command) which may cause a secondary to enter a disconnected mode are :

— the secondary power is turned on, or restored following a temporary loss of power;

— the secondary link level logic is manually reset;

— the secondary terminal is manually switched from a local (home) condition to a connected-on-the-link (on-line) condition.

1.1.1 Normal disconnected mode (NDM)

NDM is a secondary mode in which the secondary is logically disconnected from the data link and is therefore not in operational status. The secondary has normal mode respond opportunity and shall initiate a response transmission only as a result of receiving either a command frame with the P-bit set to "1" or a UP command.

In this mode, a secondary shall only action mode setting commands and the XID. A mode setting command or an XID command that cannot be actioned or any other command with the P-bit set to "1" shall cause a secondary in NDM to respond with a disconnected mode (DM) response or, if the secondary determines it is unable to function, a request for initialization (RIM). In the case where a mode setting command or an XID command has been received but cannot be actioned or a status condition is to be reported, a UP command with the P-bit set to "0" may cause a secondary in NDM to respond with DM or RIM, as appropriate.

Any command with the P-bit set to "0", other than mode setting, the XID command or the UP command, shall be ignored by a secondary in NDM.

1.1.2 Asynchronous disconnected mode (ADM)

ADM is a secondary mode in which the secondary is logically disconnected from the data link and is therefore not in operational status. The secondary has asynchronous mode respond opportunity and may initiate a response transmission in two-way alternate exchange upon detection of an idle link state, and in two-way simultaneous exchange at any time. Such a response transmission shall only consist of a request for logical connection to the primary (DM), or a request for initialization (RIM) if the secondary determines it is unable to function.

In this mode a secondary, if capable, shall action only mode setting commands and XID.

Other valid commands with the P-bit set to "1" shall cause a secondary in ADM to respond with a "disconnected mode" response or, if the secondary determines that it is unable to function, a request for initialization (RIM). Other valid commands with the P-bit set to "0" shall be ignored by the secondary.

1.2 Initialization mode (IM)

IM is the secondary mode of operation in which the secondary link control program may be initialized or regenerated by primary action, or in which other parameters to be used in the operational mode may be exchanged. IM is invoked when a primary concludes that a secondary is operating abnormally and needs its link control program corrected, and for remote

1) See ISO 4335 for all abbreviations not defined in this addendum.

upgrading of the secondary's link control program. In a similar manner, a secondary may determine it is unable to function due to program checks and request IM to obtain a good program from the primary.

A secondary shall enter the IM upon sending a UA (at its system predefined respond opportunity) in response to the receipt of a set initialization mode (SIM) command. The secondary may request SIM by sending a request initialization mode (RIM). In IM, the primary and secondary may exchange information in the predetermined manner specified for that secondary, for example UI or I frames.

IM is terminated when the secondary receives and acknowledges (via a UA response) one of the other mode setting command.

2 Definition of additional commands

The following list contains the bit encodings of the defined commands.

Command	Low-to-high bit encoding
SIM	1110P000
UP	1100P100
UI	1100P000
XID	1111P101

2.1 Set initialization mode (SIM) command

The SIM command causes the addressed secondary to initiate a station-specified procedure (or procedures) to initialize its link level control functions.

No information field is permitted with the SIM command. The secondary shall confirm acceptance of SIM by the transmission of a UA. Upon acceptance of this command, the secondary station send and receive state variables shall be set to zero.

Previously transmitted I frames that are unacknowledged when this command is actioned remain unacknowledged.

2.2 Unnumbered poll (UP) command

The UP command is used to solicit response frames from a group of secondaries (group poll) or from a single secondary (individual poll). In the case of a group poll, the mechanism employed to control response transmissions schedule (to avoid simultaneous transmissions) is not defined in this addendum. The UP command does not acknowledge receipt of any response frames that may have been previously transmitted by the secondary (or secondaries). No information is permitted with the UP command.

The secondary (or secondaries) which receives UP with a group address shall respond in the same manner as when polled using an individual address. The response frame (or frames) shall contain the sending secondary (or secondaries) individual address, plus N(S) and N(R) numbers as required by the particular response (or responses). The continuity of each secondary (or secondaries) N(S) shall be maintained. If the UP has the P-bit set to "1", each individual secondary shall respond with at least one frame, the last frame having the F-bit set to "1". If the UP has the P-bit set to "0", each individual secondary may or may not respond depending on the status of the secondary; secondary responses sent in reply to this command shall have the F-bit set to "0" in all frames of each secondary's response. A secondary which receives a UP with the P-bit set to "0" shall respond when it has :

— an I/UI frame (or frames) to send;

— an I frame to resend because it did not receive an acknowledgement;

— received but not acknowledged an I frame (or frames);

— experienced an exception condition or change of status that has not been reported;

— a status that must be reported again (for example DM, CMDR).

If idle (15 ones) is detected following receipt of a frame (or frames), or no response is received within a given period of time, it is assumed the secondary has completed, or will not initiate, transmission.

2.3 Unnumbered information (UI) command

The UI command is used to send information (for example status, operation interruption, temporal data, link level programs or parameters) to a secondary (or secondaries) without impacting the V(S) or V(R) variables at any station. There is no specified secondary response required to the UI command.

2.4 Exchange identification (XID) command

The XID command is used to cause the addressed secondary station to identify itself, and optionally to provide primary station identification and/or characteristics to the addressed secondary. An information field is optional with the XID command; if present, the information field shall contain the primary station identification. A secondary receiving an XID command shall, if capable, action the XID in any mode unless a set mode response (UA) is pending transmission, or a CMDR condition exists.

If in an operational mode (NRM, ARM) a CMDR condition may be established if the received XID information field exceeds the maximum defined storage capability of the secondary.

3 Definition of additional responses

The following list contains the bit encodings of the defined responses.

Response	Low-to-high bit encoding
DM	1111F000
RD	1100F010
RIM	1110F000
UI	1100F000
XID	1111F101

3.1 Disconnect mode (DM) response

The DM response is used to report a status where the secondary is logically disconnected from the link; and is, by system definition, in NDM or ADM.

The DM response is sent by the secondary in NDM or ADM, to inform the primary that it is still in NDM/ADM and cannot action the set mode command. No information field is permitted with the DM response.

On a switched network where the call is initiated by a secondary, the DM shall be sent to request a mode setting command. On a non-switched line, a secondary in ADM may send a DM response at any respond opportunity.

A secondary in NDM or ADM shall monitor received commands to detect a respond opportunity in order to (re)transmit DM (or RIM, XID, or RD as appropriate), i.e. no commands (other than XID) are accepted until the disconnected mode is terminated by the receipt of SNRM, SARM, SNRME, SARME or SIM.

3.2 Request disconnect (RD) response

The RD response is used to indicate to the primary that the secondary wishes to be placed in disconnected mode (NDM or ADM). In switched networks, a request for logical disconnect function at the data link level may also serve to initiate a request for a physical disconnect operation at the physical interface level; i.e., to have the requesting secondary go "on-hook". RD may be sent asynchronously if the secondary is in ARM, or, if in NRM, as a response to either a UP command or to any other command with the P-bit set to "1". No information field is permitted with the RD response.

A secondary which has sent an RD response and receives a command frame (or frames) other than DISC shall accept the command frame (or frames) if it is able to do so. If the secondary accepts the non-DISC command frame (or frames), it shall follow the normal HDLC elements of procedures to respond to the primary. Secondary acceptance of a frame other than DISC after sending an RD response shall cancel the RD response.

If the secondary still wishes to be placed in disconnected mode (NDM or ADM) it shall re-issue the RD response. If the secondary cannot accept the non-DISC frames due to internal problems it may respond with RD again.

3.3 Request initialization mode (RIM) response

The RIM is used to report a secondary need for initialization. Once a secondary station has established a RIM condition, additional commands subsequently received (other than SIM or DISC or if capable XID) shall be monitored only to detect a respond opportunity to retransmit RIM, i.e. no additional transmissions shall be accepted or actioned until the condition is reset by the receipt of SIM or DISC. No information field is permitted with this response.

3.4 Unnumbered information (UI) response

The UI response is used to send information (for example, status, operation interruption, or temporal data) to a primary without impacting the V(S) or V(R) state variables at either station. It should be noted that there may be some system-dependent restrictions on the use of the UI response, for example error control, flow control, etc.

3.5 Exchange identification (XID) response

The XID response is sent as a reply to an XID command. An information field containing the secondary station identification and/or characteristics is optionally present with the XID response. A secondary receiving an XID command shall, if capable, action the XID in any mode unless a UA response is pending or a CMDR condition exists.

On switched networks, the secondary may, at its respond opportunity, use the XID response which may optionally contain an information field, to request an XID exchange.

4 Implied changes to ISO 4335

4.1 The specification of the CMDR response not to be actioned in non-operational mode requires the following change in ISO 4335 :

Sub-clause 5.3.2.2 :

Add to the first line after secondary :

"in the operational mode"

4.2 The definition of the unnumbered poll (UP) command requires the following changes in ISO 4335 :

Sub-clause 4.1.1 :

Change the first sentence of the second paragraph to read :

"In this mode (NRM), the secondary cannot transmit until a command frame with the P-bit set to "1" or a UP command is received."

Add to the last sentence of the second paragraph :

"or a UP command with a P-bit set to "1" or "0"."

4.3 The definition of the unnumbered information (UI) and exchange identification (XID) commands require the following changes to the CMDR definition in ISO 4335 :

Sub-clause 5.3.2.2 :

Add to the second item following the first paragraph after I :

", UI or XID"

NOTE — Other additional changes to ISO 4335 may be required in addition to those above.

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Data communication — High level data link control procedures — Elements of procedures

0 INTRODUCTION

High level data link control (HDLC) procedures are designed to permit synchronous bit sequence independent data transmission.

This International Standard describes HDLC elements of procedures as outlined in clause 1. The reader should note that further study is in progress to define additional elements which enhance this document. This further study may result in a need for minor changes to the text of this International Standard.

In HDLC procedures, the normal cycle of the code transparent data communication between two data stations consists of the transfer of frames containing information from the data source to the data sink, acknowledged by a frame in the opposite direction. Until the data terminal equipment (DTE) comprising the data source receives the reply, it must hold the original information in memory in case the need should arise for retransmissions.

A data link involves two or more participating stations. For control purposes, one station on the link must assume responsibility for the organization of data flow and for link level error recovery operations. The station assuming these responsibilities is known as the primary and the frames it transmits are referred to as command frames. The other stations on the link are known as secondaries and frames they transmit are referred to as response frames.

For the transfer of data, the following two cases of data link control are considered : In the first case, the DTE comprising the data source performs a primary data link control function and controls the DTE comprising the data sink that is associated with a secondary data link control function, by select type commands.

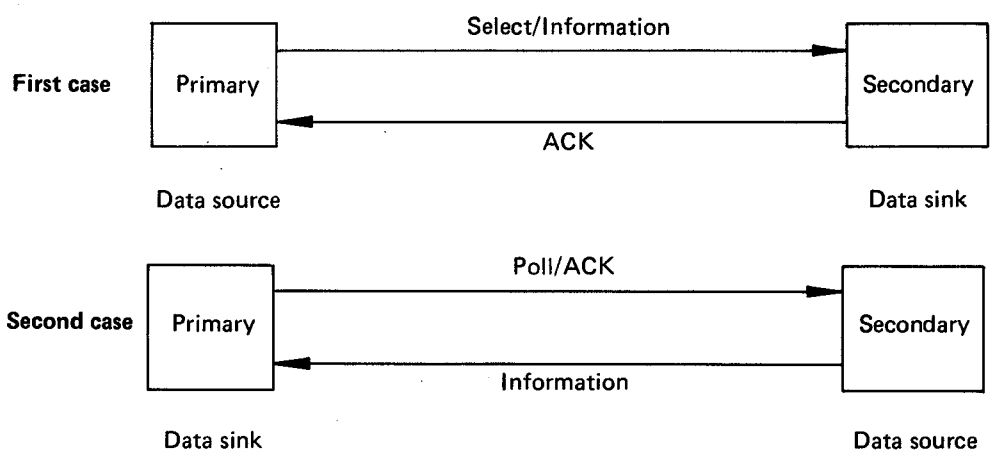
In the second case, the DTE comprising the data sink performs a primary data link control function and controls the DTE comprising the data source that is associated with a secondary data link control function, by poll-type commands.

The information flows from the data source to the data sink and the acknowledgements will always be transmitted in the opposite direction.

These two cases of control may be combined differently so that the data link becomes capable of two-way alternate communication, or two-way simultaneous communication.

The control of traffic between the data source and the data sink is effected by means of a numbering scheme, which is cyclic within a modulus specified in the standard and measured in terms of frames. An independent numbering scheme is used for each data source/data sink combination on the link.

The acknowledgement function is accomplished by the data sink informing the data source of the next expected sequence number. This can be done in a separate frame, not containing information, or within the control field of a frame containing information.



1 SCOPE AND FIELD OF APPLICATION

This International Standard describes elements of data link control procedures for synchronous bit sequence independent data transmission using the HDLC frame structure (see ISO 3309[1]) and independent frame numbering in both directions.

These HDLC elements of procedures are described specially in terms of the actions that occur on receipt of commands at a secondary.

This International Standard is intended to cover a wide range of applications, for instance, one-way, two-way alternate or two-way simultaneous data communication between DTE's which are usually buffered, including operations on different types of data circuits, for example, multipoint/point-to-point connections, duplex/half-duplex transmission, switched or non-switched, etc.

The defined HDLC elements of procedures are to be considered as a common basis for establishing different types of control procedures. This International Standard does not define any single system and should not be regarded as a specification for a data communication system. Not all the commands or responses, respectively, might be required for a particular system implementation.

A DTE intended to be operated within the constraints of this International Standard provides a high degree of compatibility, if it implements all features of the stipulated class of operation as specified in other HDLC standards.

2 OPERATIONAL MODES

In this International Standard two operational modes are defined for secondary stations; normal response mode (NRM) and asynchronous response mode (ARM).

2.1 Normal response mode (NRM)

NRM is an operational mode in which the secondary may initiate transmission only as the result of receiving explicit permission to do so from the primary. After receiving permission, the secondary shall initiate a response transmission. The response transmission may consist of one or more frames while maintaining an active channel state. The last frame of the response transmission will be explicitly indicated by the secondary. Following the indication of the last frame, the secondary will stop transmitting until explicit permission is again received from the primary.

2.2 Asynchronous response mode (ARM)

ARM is an operational mode in which the secondary may initiate transmission without receiving explicit permission from the primary. Such an asynchronous transmission may contain single or multiple frames and is used for information field transfer and/or to indicate status changes in the secondary (for example, the number of the next expected information frame, transition from a ready to a busy condition or vice versa, occurrence of an exception condition).

3 CONTROL FIELD AND PARAMETERS

3.1 Control field formats

The three formats defined for the control field are used to perform numbered information transfer, numbered supervisory functions and unnumbered control functions.

Control field format for	Control field bits							
	1	2	3	4	5	6	7	8
Information transfer command/ response (I frame)	0	N(S)			P/F	N(R)		
Supervisory commands/responses (S frame)	1	0	S		P/F	N(R)		
Unnumbered commands/responses (U frame)	1	1	M		P/F	M		

where

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

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

S = Supervisory function bits

M = Modifier function bits

P/F = Poll bit – primary transmissions
Final bit – secondary transmissions
(1 = Poll/Final)

3.1.1 *Information transfer format – I*

The I format is used to perform an information transfer. Unless otherwise specified, it is the only format which may contain an information field. The functions of N(S), N(R), and P/F are independent, i.e. each I frame has an N(S) sequence number, an N(R) sequence number which may or may not acknowledge additional frames at the receiving station, and a P/F bit that may be set to "1" or "0".

3.1.2 *Supervisory format – S*

The S format is used to perform link supervisory control functions such as acknowledge I frames, request retransmission of I frames, and to request a temporary suspension of transmission of I frames.

1) ISO 3309, *Data communication – High level data link control procedures – Frame structure.*

3.1.3 *Unnumbered format – U*

The U format is used to provide additional link control functions. This format contains no sequence numbers and consequently 5 "modifier" bit positions are available which allows definition of up to 32 additional command functions and 32 additional response functions.

3.2 Parameters

The various parameters associated with the control field formats are described in the following sub-clauses.

3.2.1 *Modulus*

Each I frame is 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 for the unextended control field, and the sequence numbers cycle through the entire range. See 5.4 for description of the extended control field modulus.

The maximum number of sequentially numbered I frames that the primary or secondary may have outstanding (i.e. unacknowledged at any given time may never exceed one less than the modulus of the sequence numbers. This restriction is to prevent any ambiguity in the association of transmitted I frames with sequence numbers during normal operation and/or error recovery action.

NOTE – The number of outstanding I frames may be further restricted by the data station storage capability, i.e. the number of I frames that can be stored for transmission and/or retransmission in the event of a transmission error. Optimum link efficiency can only be obtained, however, if the minimum data station frame storage capacity is equal to or greater than the round trip transmission delay.

3.2.2 *Frame variables and sequence numbers*

In HDLC operation each data station maintains an independent send sequence number N(S) and receive sequence number N(R) on the I frames it sends and receives. Each secondary then maintains an N(S) count on the I frames it transmits to the primary, and an N(R) count on the I frames it has correctly received from the primary. In the same manner the primary maintains independent N(S) and N(R) counts for I frames sent to and recevied from each secondary on the link.

3.2.3 *Send state variable V(S)*

The send state variable denotes the sequence number of the next in sequence I frame to be transmitted. The send state variable can take on the value 0 through MODULUS minus ONE (where MODULUS is the modulus of the sequence numbering scheme and the numbers cycle through the entire range). The value of the send state variable is incremented by one with each successive I frame transmission, but cannot exceed N(R) of the last received frame by more than MODULUS minus ONE.

3.2.4 *Send sequence number N(S)*

Only I frames contain N(S), the send sequence number of transmitted frames. Prior to transmission of an in-sequence I frame, the value of N(S) is updated to equal the value of the send state variable.

3.2.5 *Receive state variable V(R)*

The receive state variable denotes the sequence number of the next in-sequence I frame to be received. This receive state variable can take on the values 0 through MODULUS minus ONE (where MODULUS is the modulus of the sequence numbering scheme and the numbers cycle through the entire range). The value of the receive state variable is incremented by the receipt of an error-free, in-sequence I frame whose send sequence number N(S) equals the receive state variable.

3.2.6 *Receive sequence number N(R)*

All I frames and S frames contain N(R), the expected sequence number of the next received I frame. Prior to transmission of a frame of the above types, the value of N(R) is updated to equal the current value of the receive state variable. N(R) indicates that the station transmitting the N(R) has correctly received all I frames numbered up to N(R) – 1.

See 5.3.2.2 for definitions of the range of values of N(R).

3.2.7 *Poll/Final (P/F) bit*

The poll (P/F) bit is used by the primary to solicit (poll) a response or sequence of responses from secondaries.

The final (P/F) bit is used by a secondary :

a) in NRM to indicate the final frame transmitted as the result of a previous soliciting (poll) command;

b) in ARM to indicate the response frame transmitted as the result of a soliciting (poll) command.

See clause 4 for further descriptions of the P/F bit functions.

3.3 Data link channel states

3.3.1 *Active channel state*

A channel is in an ACTIVE condition when the primary or a secondary is actively transmitting a frame, a single abort sequence or interframe time fill. In the ACTIVE state the right to continue transmission is reserved.

3.3.1.1 ABORT

Aborting a frame is accomplished by transmitting at least seven contiguous one bits (with non-inserted zeroes). Receipt of seven contiguous one bits is interpreted as an abort and the receiving station will ignore the frame.

NOTE – In sending more than seven one bits to abort, care must be taken that if 15 or more one bits are sent, including those already transmitted at the time of decision on abort, an IDLE channel state will result.

3.3.1.2 INTERFRAME TIME FILL

Interframe time fill is accomplished by transmitting continuous flags between frames. There is no provision for time fill within a frame.

3.3.2 *Idle channel state*

A channel is defined to be in an IDLE condition when a continuous ones state is detected that persists for at least 15 bit times; IDLE condition indicates that the remote station has terminated transmission.

4 FUNCTIONS OF THE POLL/FINAL (P/F) BIT

The poll/final (P/F) bit serves a function in both command frames and response frames. In command frames the P/F bit is referred to as the P bit. In response frames it is referred to as the F bit.

4.1 Poll bit function

The P bit is used to solicit a response from the secondary.

On a link only one frame with a P bit set to "1" may be outstanding at a given time. Before a primary can issue another frame with P bit set to "1" it must receive a response frame from the secondary with the F bit set to "1". If no valid response frame is obtained within a system defined time-out, the retransmission of a command with the P bit set to "1" for error recovery purposes is permitted.

4.1.1 *Poll bit functions in NRM*

In NRM the P bit is set to "1" to solicit response frames from the secondary.

In this mode the secondary cannot transmit until a command frame with the P bit set to "1" is received. The primary can solicit I frames by sending an I frame with the P bit set to "1" or by sending certain S frames (RR, REJ or SREJ) with the P bit set to "1".

The primary can also restrict the secondary from transmitting I frames by sending an RNR S frame with the P bit set to "1".

4.1.2 *Poll bit functions in ARM*

In ARM, I frames can be transmitted by the secondary on an asynchronous basis. The P bit zero set to "1" is used, to solicit a response, at the earliest opportunity, with the F bit set to "1". For example, if the primary wants to get positive acknowledgement that a particular command has been received, it may set the P bit in the command to "1". This will force a response from the secondary as outlined in 4.2.

4.2 Final bit functions

4.2.1 *Final bit functions in NRM*

In NRM the secondary must set the F bit to "1" in the last frame of its response. Following transmission of the frame with the F bit set to "1" the secondary must stop transmitting until a subsequent command frame with a P bit set to "1" is received.

4.2.2 *Final bit function in ARM*

In ARM, the secondary will transmit a response frame with the F bit set to "1" only in response to a received command frame with the P bit set to "1". Following the receipt of a command frame with the P bit set to "1", the secondary must initiate transmission of a response with the F bit set to "1".

In the case of a two-way simultaneous communication where the secondary is transmitting when the command frame with the P bit set to "1" is received, the F bit will be set to "1" in the earliest possible subsequent response frame to be transmitted.

In ARM, the transmission of a response frame with the F bit set to "1" does not require the secondary to stop transmitting. Additional responses frames may be transmitted following the response frame which had the F bit set to "1". Thus, in ARM the F bit is not to be interpreted as the end of transmission by the secondary. It is only to be interpreted as indicating the response of the secondary to the previous command frame with the P bit set to "1".

4.3 Use of the P/F bit to assist in error recovery (see also clause 6)

As the P and F bits are always exchanged as a pair (for every P there is one F, and the P cannot be issued until the previous P has been matched with an F) the N(R) contained in a frame with a P or F bit set to "1" can be used to detect I frame sequence errors. This capability can provide early detection of I frame sequence errors and indicate the frame sequence number to begin retransmission. This capability is referred to as check pointing.

4.3.1 *Check pointing in NRM*

In NRM the N(R) of a received frame which has the P (command) or F (response) bit set to "1" shall initiate error recovery if N(R) does not acknowledge at least all I frames transmitted previous to and concurrent with the last frame which was transmitted with the P or F bit set to "1". In all cases the N(R) of a correctly received I or S frame shall confirm previously transmitted I frames through N(R) − 1.

4.3.2 *Check pointing in ARM*

In ARM the N(R) of a received frame which has the P (command) or F (response) bit set to "1" will cause the receiver to initiate error recovery if the N(R) does not acknowledge at least all I frames transmitted previous to and concurrent with the last frame which was transmitted with the P or F bit set to "1".