

Telecontrol equipment and systems —

Part 5: Transmission protocols —

Section 5.2 Link transmission procedures

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- Association of Consulting Engineers
- BAMEMA (BEAMA)
- BEAMA Ltd.
- EEA (the Association of Electronics, Telecommunications and Buisness Equipment Industries)
- Electricity Supply Industry in United Kingdom
- GAMBICA (BEAMA Ltd.)
- North of Scotland Hydro-Electric Board
- Telecommunication Engineering and Manufacturing Association
- Transmission and Distribution Association (BEAMA Ltd.)

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Contents

	Page
Committees responsible	Inside front cover
National foreword	iii
Foreword	2
Introduction	3
1 Scope and object	3
1.1 Scope	3
1.2 Object	3
2 Normative references	3
3 Formats and structures of standard transmission frames	4
3.1 Format FT 1.1	4
3.2 Format FT 1.2	5
3.3 Format FT 2	6
3.4 Format FT 3	7
4 Service primitives and elements of transmission procedures	8
4.1 SEND/NO REPLY service	9
4.1.1 Service primitives	9
4.1.2 Transmission procedure	9
4.2 SEND/CONFIRM service	9
4.2.1 Service primitives	9
4.2.2 Transmission procedure	10
4.3 REQUEST/RESPOND service	10
4.3.1 Service primitives	10
4.3.2 Transmission procedures	10
5 Unbalanced transmission	11
5.1 Specification of length, control and address fields	11
5.1.1 Length field	11
5.1.2 Control field	11
5.1.3 Address field	13
5.2 Unbalanced transmission services	13
5.3 Unbalanced transmission procedures	14
5.3.1 SEND/NO procedures	14
5.3.2 Undisturbed SEND/CONFIRM procedures	15
5.3.3 Disturbed SEND/CONFIRM procedures	15
5.3.4 Undisturbed REQUEST/RESPOND procedures	15
5.3.5 Disturbed REQUEST/RESPOND procedures	15
6 Balanced transmission	23
6.1 Specification of length, control, and address fields	23
6.1.1 Length field	23
6.1.2 Control field	23
6.1.3 Address field	24
6.2 Balanced transmission services	25
6.3 Balanced transmission procedures	25
6.3.1 SEND/NO REPLY procedures	25
6.3.2 Undisturbed SEND/CONFIRM procedures	26
6.3.3 Undisturbed procedures with data flow control	26
6.3.4 Disturbed SEND/CONFIRM procedures	26
Annex A (normative) Time out interval for repeated frame transmission	33

	Page
Annex ZA (normative) Other international publications quoted in this standard with the references of the relevant European publications	39
Figure 1 — Relationship between service primitives and transmission procedures for basic link services	8
Figure 2 — Example of the interaction between a polling procedure and an event-initiated transmission	14
Figure 3 — Unbalanced transmission procedures, undisturbed SEND/CONFIRM procedures	16
Figure 4 — Unbalanced transmission procedures, disturbed SEND/CONFIRM procedures	17
Figure 5 — Unbalanced transmission procedures, undisturbed REQUEST/RESPOND procedures	18
Figure 6 — Unbalanced transmission procedures, undisturbed REQUEST/RESPOND procedures	19
Figure 7 — Unbalanced transmission procedures, undisturbed REQUEST/RESPOND procedures	20
Figure 8 — Unbalanced REQUEST/RESPOND transmission procedures, disturbed REQUEST frame	21
Figure 9 — Unbalanced REQUEST/RESPOND transmission procedures, disturbed RESPOND frame	22
Figure 10 — Example of the interaction of service primitives and transmission procedures in a balanced system	25
Figure 11 — Balanced transmission procedures, undisturbed SEND/CONFIRM procedures	27
Figure 12 — Balanced transmission procedures, data flow control	28
Figure 13 — Balanced transmission procedures, disturbed SEND frame	29
Figure 14 — Balanced transmission procedures, disturbed SEND and ignored CONFIRM frame	30
Figure 15 — Balanced transmission procedures, disturbed CONFIRM frame	31
Figure 16 — Balanced transmission procedures, disturbed channel in one direction	32
Figure A.1 — Unbalanced transmission procedures, disturbed primary frame	35
Figure A.2 — Unbalanced transmission procedures, disturbed secondary frame	36
Figure A.3 — Balanced transmission procedures, disturbed primary frame	37
Figure A.4 — Balanced transmission procedures, disturbed secondary frame	38
Table 1 — Unbalanced transmission, function codes of control field in messages sent from primary (PRM = 1)	12
Table 2 — Unbalanced transmission, function codes of control field in messages sent from secondary (PRM = 0)	12
Table 3 — Balanced transmission, function codes of control field in messages sent from primary (PRM = 1)	24
Table 4 — Balanced transmission, function codes of control field in messages sent from secondary (PRM = 0)	24
List of references	Inside back cover

National foreword

This Section of BS 7404 has been prepared under the direction of the Power Electrical Engineering Standards Policy Committee and is identical with IEC Publication 870-5-2:1992 *Telecontrol equipment and systems — Part 5: Transmission protocols — Section 2: Link transmission procedures*, published by the International Electrotechnical Commission (IEC).

In 1993 the European Committee for Electrotechnical Standardization (CENELEC) accepted IEC 870-5-2:1992 as European Standard EN 60870-5-2:1993. As a consequence of implementing the European Standard this British Standard is renumbered as BS EN 60870-5-2 and any reference to BS 7404-5.2 should be read as a reference to BS EN 60870-5-2.

The international standard does not give the up-to-date relationship between this Part of the IEC standard and the other published and envisaged Parts and Sections. Other Parts and Sections of this British Standard are as follows.

- *Part 1: General considerations;*
- *Section 1.1: General principles;*
- *Section 1.2: Guide for specifications;*
- *Section 1.3: Glossary;*
- *Section 1.4: Basic aspects of telecontrol data transmission¹⁾;*
- *Part 2: Operating conditions;*
- *Section 2.1: Specification for classes of environmental conditions and power supplies;*
- *Section 2.2: Specification for electromagnetic compatibility and erosive and corrosive influences²⁾;*
- *Part 3: Specification for interfaces (electrical characteristics);*
- *Part 4: Specification of performance;*
- *Part 5: Transmission protocols*
- *Section 5.1: Specification for transmission frame formats;*
- *Section 5.2: Specification for link transmission procedures;*
- *Section 5.3: Specification for structure of application data;*
- *Section 5.4: Specification for coding specifications of application data;*
- *Part 6: Specification for telecontrol protocols compatible with ISO and CCITT standards²⁾.*

Cross-references

International standard	Corresponding British Standard
	BS 7404 <i>Telecontrol equipment and systems</i>
IEC 870-1-1:1988	Section 1.1:1991 <i>General principles</i> (Identical)
IEC 870-5-1:1990	Section 5.1:1991 <i>Specification for transmission frame formats</i> (Identical)

The Technical Committee has reviewed the provisions of IEC 50(371):1984 to which normative reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard.

¹⁾ Will be published after IEC 870-1-4 has been published.

²⁾ Not yet published, envisaged as future work by IEC.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, the EN title page, pages 2 to 40, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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Telecontrol equipment and systems

Part 5: Transmission protocols

Section 2: Link transmission procedures

(IEC 870-5-2:1992)

Matériels et systèmes de téléconduite
Partie 5: Protocoles de transmission
Section 2: Procédures de transmission de
liaison de données
(CEI 870-5-2:1992)

Fernwirkeinrichtungen und Fernwirkssysteme
Teil 5: Übertragungsprotokolle
Hauptabschnitt 2: Übertragungsprozeduren
der Verbindungsschicht
(IEC 870-5-2:1992)

This European Standard was approved by CENELEC on 1993-07-06. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B-1050 Brussels

Foreword

The CENELEC questionnaire procedure, performed for finding out whether or not the International Standard IEC 870-5-2:1992 could be accepted without textual changes, has shown that no common modifications were necessary for the acceptance as European Standard.

The reference document was submitted to the CENELEC members for formal vote and was approved by CENELEC as EN 60870-5-2 on 6 July 1993.

The following dates were fixed:

- latest date of publication
of an identical national
standard (dop) 1994-08-01
- latest date of withdrawal
of conflicting national
standards (dow) 1994-08-01

Annexes designated “normative” are part of the body of the standard. In this standard, Annex A and Annex ZA are normative.

Introduction

This section of IEC 870-5 is part of a series which highlights specific requirements and conditions for data transmission in telecontrol systems and describes ways to meet those requirements.

In terms of the OSI (Open System Interconnection) reference model of ISO-CCITT, which subdivides communication into seven layers, this section is concerned with the procedures required by the second layer: the link layer.

Section 1 covers the two bottom layers: the physical layer and the link layer, the latter being explained in terms of admissible frame formats and rules for frame synchronization. This section specifies standard link transmission procedures which operate on the link layer.

1 Scope and object

1.1 Scope

This section of IEC 870-5 applies to telecontrol equipment and systems with coded bit serial data transmission for monitoring and controlling geographically widespread processes.

The defined link procedures are restricted to message transmission sequences operating with size 1 windows. This means that the link layer of the primary station (station that initiates a message transfer) accepts a request for a new message transfer only when a previously accepted request for a message transfer is terminated either successfully or with an error indication. The procedures are applicable to balanced and unbalanced transmission in telecontrol systems using half duplex or duplex transmission channels.

1.2 Object

The standard transmission procedures defined by this section are applicable to point-to-point, multiple point-to-point, multipoint-star, multipoint-partyline and multipoint-ring configurations as described in 4.4 of IEC 870-1-1.

The data transmission functions in these systems are composed of three basic types of link transmission services, namely:

1. SEND/NO REPLY
2. SEND/CONFIRM
3. REQUEST/RESPOND

The two services SEND/CONFIRM and REQUEST/RESPOND consist of a sequence of non-separable dialogue elements between requesting stations and responding stations.

The protocol defined in this section accepts and processes only a single link transmission service at a time in each direction of a bidirectional communication system. Each transmission service is terminated either successfully or with error reports before the next transmission service begins. This means that the window size for successive packet transfers is 1 and the specified error recovery for the transmission services SEND/CONFIRM and REQUEST/RESPOND utilize the stop-and-wait method for automatic repeat requests (ARQ).

In point-to-point configurations equipped with duplex channel operation, the defined protocol supports balanced transmission procedures, that is simultaneous data transmission services in both directions of the communication link. This enables outstations to report spontaneous events to the control station as they occur, without having to be polled. This reduces reporting delays and leads to faster data acquisition. However, the use of an individual duplex communications channel to each outstation leads to increased equipment costs.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this section of IEC 870-5. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this section of IEC 870-5 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.

IEC 50(371):1984, *International Electrotechnical Vocabulary (IEV) — Chapter 371: Telecontrol*.

IEC 870-1-1:1988, *Telecontrol equipment and systems — Part 1: General considerations — Section 1: General principles*.

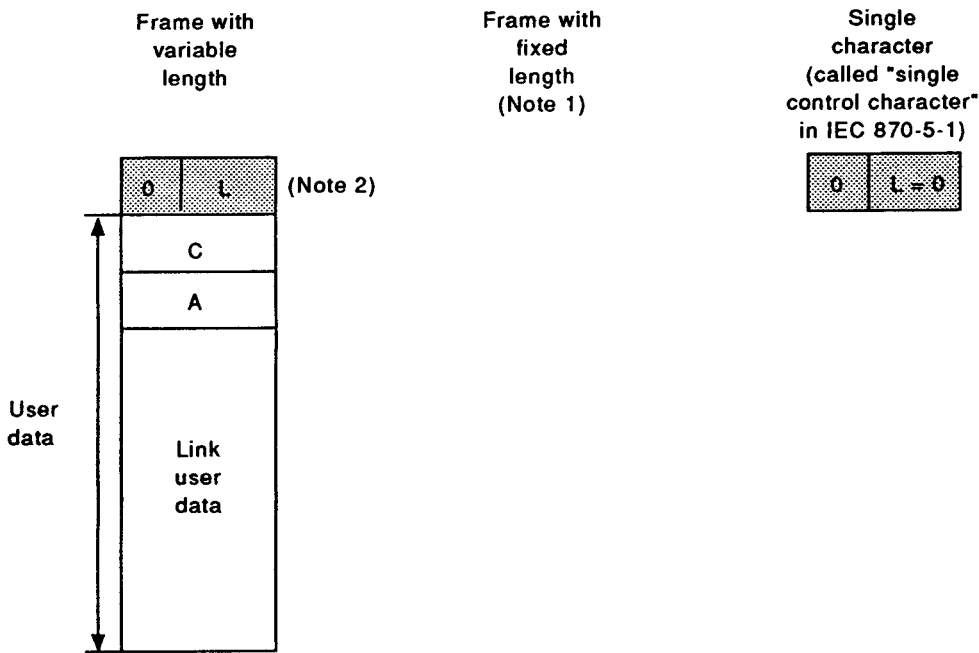
IEC 870-5-1:1990, *Telecontrol equipment and systems — Part 5: Transmission protocols — Section 1: Transmission frame formats.*

3 Formats and structures of standard transmission frames

The transmission procedures defined in this section provide protection against residual (i.e. undetected) transmission errors in the range of integrity class I1, specified in IEC 870-5-1, if the transmission frame format FT 1.1 is used and if the transmission rules specified by that section are observed. Residual transmission errors in the range of integrity class I2 are achieved if one of the transmission frame formats FT 1.2, FT 2 or FT 3, specified by that section, are utilized and if the corresponding transmission rules are observed. Only one chosen transmission frame format may be used on any given physical communications channel in a system. The order of fields in the frames is generally as follows:

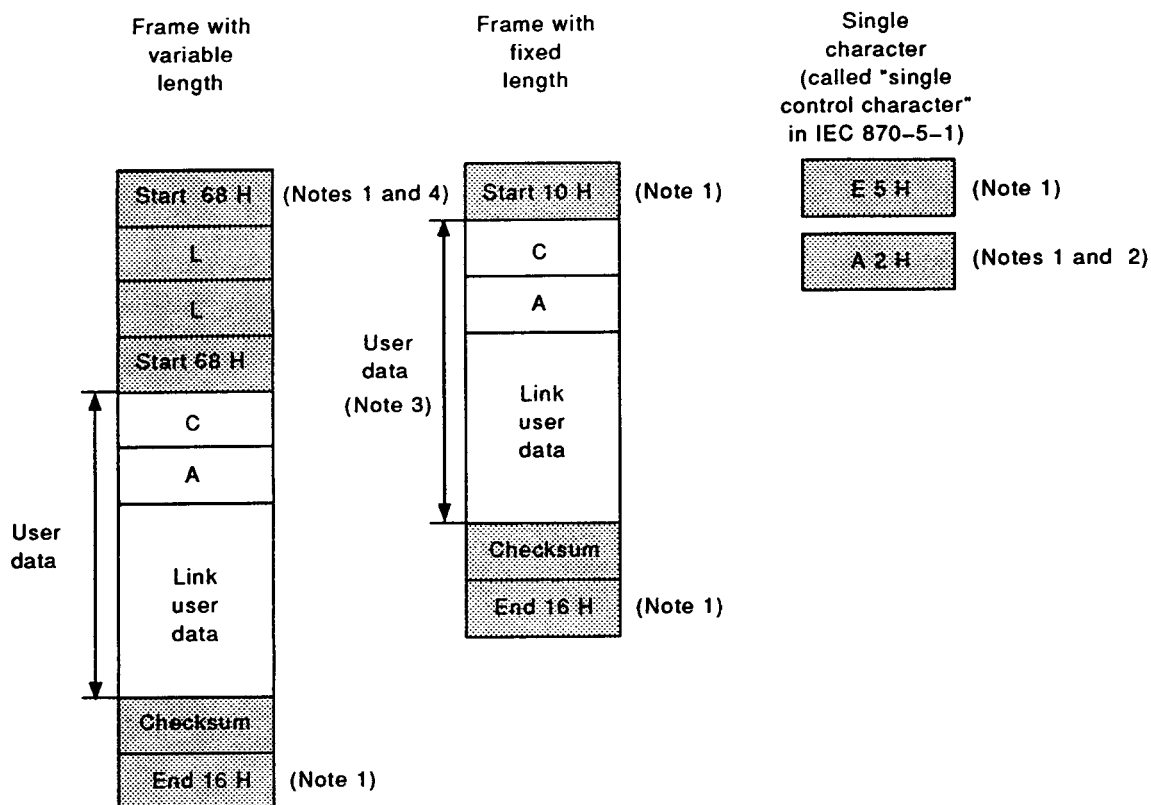
- Length (one octet)
- Control (one octet)
- Address (one or more octets, by agreement)
- Link user data (n octets)

3.1 Format FT 1.1



L: length field range: 0...127
L specifies the number of subsequent user data octets including the control and address fields
C: control field
A: address field, optional
NOTE 1 There is no special frame with a fixed length; the variable length frame is used in all cases.
NOTE 2 The shaded fields have already been defined in IEC 870-5-1.
The unshaded fields are the "user data" of the frame as indicated in IEC 870-5-1.

3.2 Format FT 1.2



L: length field range: 0...255

L specifies the number of subsequent user data octets including the control and address fields

C: control field

A: address field, optional

NOTE 1 Specified data octets are represented in hexadecimal notation, in which bits with weights $2^7 \dots 2^4$ denote the left hexadecimal character and bits with weights $2^3 \dots 2^0$ denote the right hexadecimal character,

e.g.: $68 \text{ H} = \frac{0110}{6} \frac{1000}{8}$

The sequence of bit transmission begins, as defined in IEC 870-5-1, with the least significant bit 2^0 .

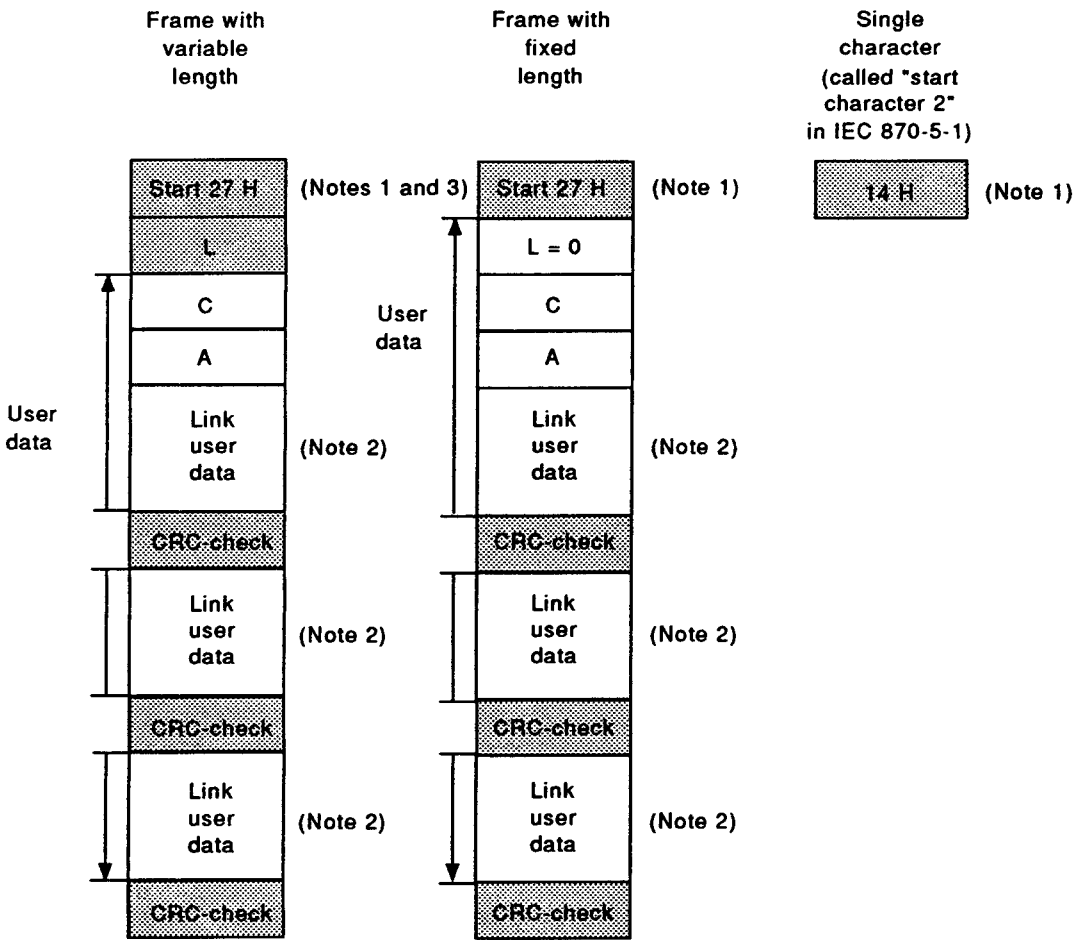
NOTE 2 Reserved for special use by agreement.

NOTE 3 A fixed number of user data octets is specified per system.

NOTE 4 The shaded fields have already been defined in IEC 870-5-1.

The unshaded fields are the "user data" of the frame as indicated in IEC 870-5-1.

3.3 Format FT 2



L: length field range: 0...255
L specifies the number of subsequent user data octets including the control and address octets and excluding the CRC-check octets
L = 0 specifies a fixed frame length with at least 2 user data octets
L > 0 specifies a variable frame length with L user data octets

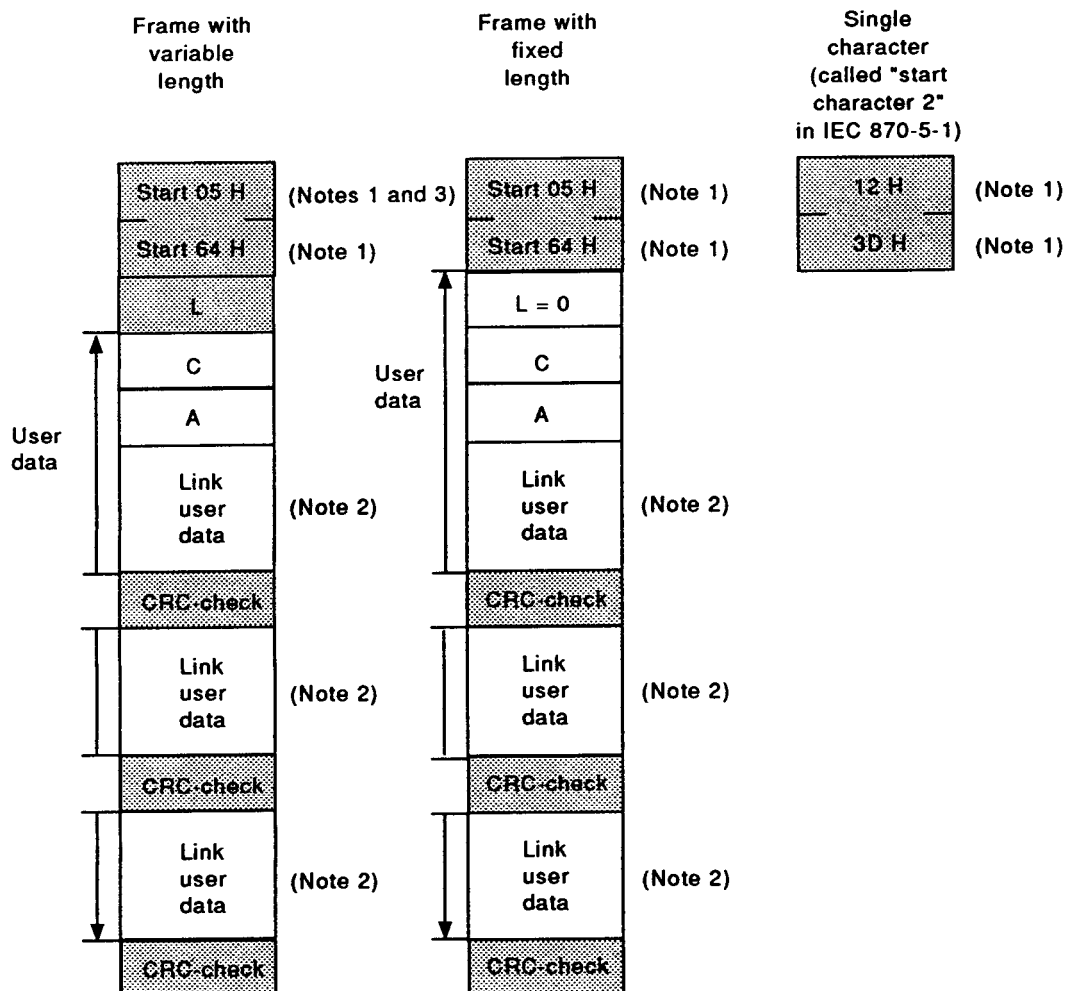
C: control field
A: address field, optional
CRC-check: Cyclic Redundancy Check

NOTE 1 Specified data octets are represented in hexadecimal notation,

e.g. 27 H = $\frac{0010}{2} \frac{0111}{7}$

The sequence of bit transmission begins, as defined in IEC 870-5-1, with the most significant bit.
NOTE 2 Up to 15 user data octets are completed by a CRC-check octet (see IEC 870-5-1, subclause 6.2.4.3.1, R3).
NOTE 3 The shaded fields have already been defined in IEC 870-5-1.
The unshaded fields are the "user data" of the frame as indicated in IEC 870-5-1.

3.4 Format FT 3



L: length field range: 0...255

L specifies the number of subsequent user data octets including the control and address octets and excluding the CRC-check octets

L = 0 specifies a fixed frame length with at least 2 user data octets

L > 0 specifies a variable frame length with L user data octets

C: control field

A: address field, optional

CRC-check: Cyclic Redundancy Check

NOTE 1 Specified data octets are represented in hexadecimal notation,

e.g. 05 H = $\frac{0000}{0} \frac{0101}{5}$ 64 H = $\frac{0110}{6} \frac{0100}{4}$

The sequence of bit transmission begins, as defined in IEC 870-5-1, with the most significant bit.

NOTE 2 Up to 16 user data octets are completed by a CRC-check octet (see IEC 870-5-1, subclause 6.2.4.4.1, R3).

NOTE 3 The shaded fields have already been defined in IEC 870-5-1.

The unshaded fields are the "user data" of the frame as indicated in IEC 870-5-1.

4 Service primitives and elements of transmission procedures

The data communication is described by

- “service primitives” crossing the interface between the service user and the link layer, and associated
- “transmission procedures” of the link between communicating stations.

The contents of the service primitives (parameters, conditions, etc.) are not standardized in this section.

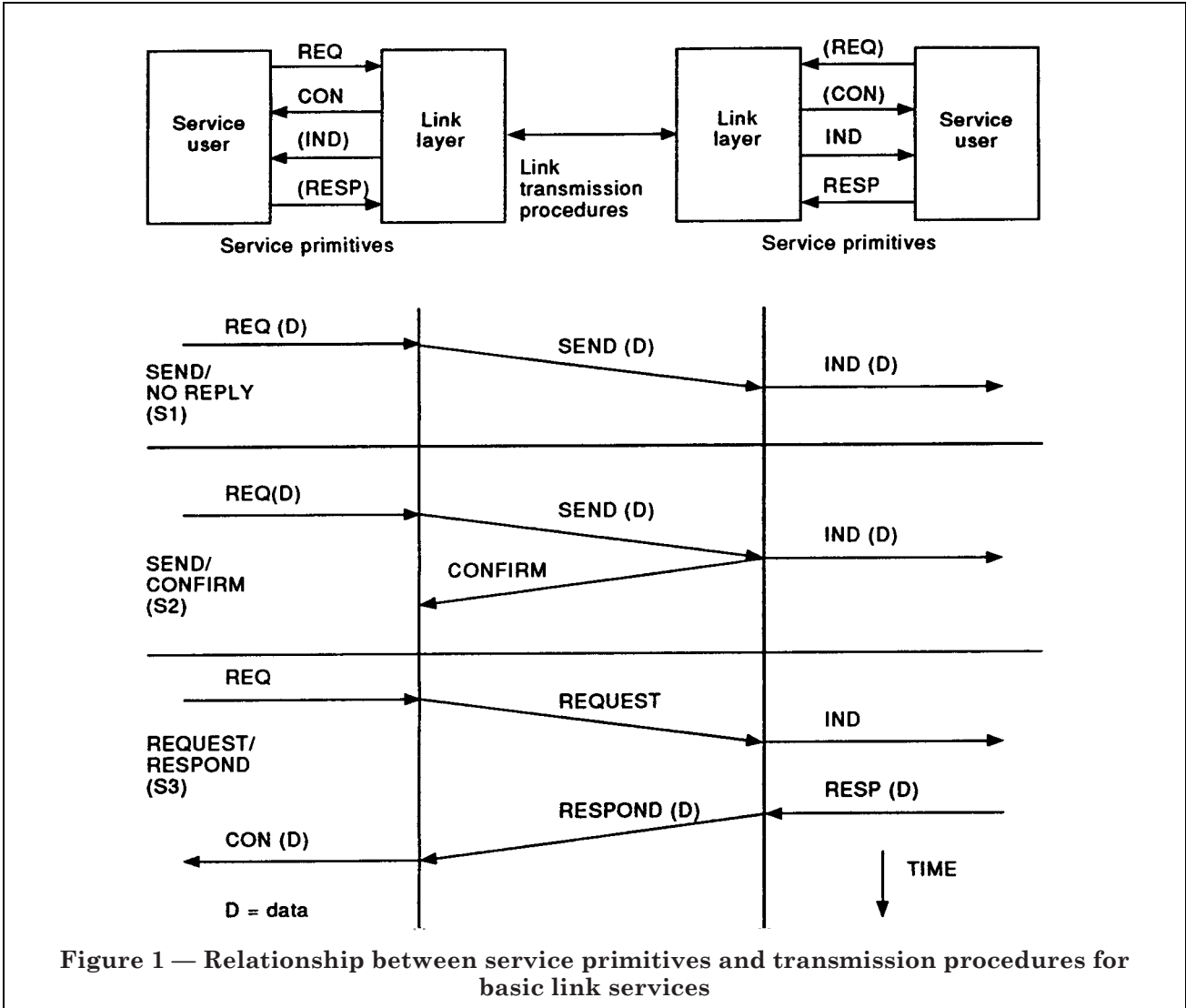


Figure 1 shows error free transmission procedures of basic link services. Transmission errors are only detected by receiving stations. A secondary station receiving a disturbed SEND or REQUEST frame does not reply. This is detected by the primary station timing out, because the expected CONFIRM or RESPOND frame is not received. Also a primary station receiving a disturbed CONFIRM or RESPOND frame ignores it and consequently detects the error.

There are four types of primitives that may contain user data and sets of parameters and conditions, namely:

- request primitive REQ:* a request issued by the service user to invoke some procedure in the link layer;
- confirmation primitive CON:* a confirmation issued by the link layer to complete the procedure previously invoked by a request;

<i>indication primitive IND:</i>	a indication issued by the link layer to announce the wish to deliver data to the service user, or to invoke some service user procedure;
<i>response primitive RESP:</i>	a response issued by the service user to announce the completion of a procedure previously invoked by an indication.

NOTE Confirmations or responses can be positive or negative, as appropriate to the circumstances.

Typical contents of the service primitives are parameters, conditions and user data as follows:

- user data;
- types of transmission service (function code, e.g. SEND/CONFIRM);
- negative/positive confirmations or responses;
- DFC (data flow control);
- ACD (access demand);
- number of repetitions (e.g. 3);
- error status (e.g. after a repeated transmission error);
- status of the layer (e.g. restart conditions).

4.1 SEND/NO REPLY service

4.1.1 Service primitives

— Primary station

The link layer accepts the request primitive REQ (SEND/NO REPLY) given by the link user when it is able to transmit the message. If the link layer is not able to transmit the message (disconnection from line or error state) a negative confirmation primitive CON (negative, SEND/NO REPLY, error status) is returned.

— Secondary station

An indication primitive IND (no response required) announces the reception of the message to the service user of the secondary station.

4.1.2 Transmission procedure

The specified SEND frame (see Table 1 and Table 3) is transmitted when the transmission procedure of a previous service is terminated

After the transmission of the frame a line idle interval is provided whose length is specified as an interval between frames upon detection of a transmission error (see IEC 870-5-1, subclause 6.2.4.1, transmission rule R4 for FT 1.1 frames, subclause 6.2.4.2.1, transmission rule R4 for FT 1.2 frames, subclause 6.2.4.3.1, transmission rule R5 for FT 2 frames and subclause 6.2.4.4.1, transmission rule R5 for FT 3 frames).

The line idle interval may be reduced below these figures by using the carrier off condition to represent idle line.

4.2 SEND/CONFIRM service

4.2.1 Service primitives

— Primary station

The link layer accepts the request primitive REQ (SEND/CONFIRM, number of repetitions) and invokes the SEND/CONFIRM procedure, unless it is unable to transmit the message, in which case it returns a negative confirmation primitive CON (negative SEND/CONFIRM, error status) to the service user.

If a negative acknowledgement is received from the secondary station, a negative confirmation primitive CON (negative SEND/CONFIRM, error status) is returned to the user. A negative confirmation primitive is also returned to the user if the maximum number of repeated message transmissions expires without success.

— Secondary (confirming) station

An indication primitive IND (no response required) announces the reception of the message to the user at the confirming station if a SEND frame which is not a repeat of the previously received frame is received in the designated destination.