

Telecontrol equipment and systems —

Part 5: Transmission protocols —

Section 102: Companion standard for the transmission of integrated totals in electric power systems

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ICS 33.200

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- Building Automation and Mains Signalling Association (BASMA)
- Electricity Association
- Federation of the Electronics Industry
- GAMBICA
- Institution of Electrical Engineers
- Transmission and Distribution Association (BEAMA Ltd.)

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National foreword

This British Standard has been prepared by Technical Committee PEL/57 and is the English language version of EN 60870-5-102:1996 *Telecontrol equipment and systems. Part 5: Transmission protocols — Section 102: Companion standard for the transmission of integrated totals in electric power systems*, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with IEC 870-5-102:1996, published by the International Electrotechnical Commission (IEC).

Cross-references

Publication referred to	Corresponding British Standard
IEC 50(371):1984	BS 4727 <i>Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms</i> Part 2 <i>Terms particular to power engineering</i> Group 12:1990 <i>Telecontrol terminology</i> BS 7404 <i>Telecontrol equipment and systems</i> Part 1 <i>General considerations</i>
IEC 870-1-1:1988	Section 1.1:1991 <i>General principles</i>
IEC 870-1-3:1990	Section 1.3:1991 <i>Glossary</i>
IEC 870-1-4:1994	Section 1.4:1995 <i>Guide for basic aspects of telecontrol data transmission and organization of standards</i> BS 7404-5 and BS 7404-6 BS EN 60870 <i>Telecontrol equipment and systems</i> BS EN 60870-5 <i>Transmission protocols</i>
EN 60870-5-1:1993 (IEC 870-5-1:1990)	BS EN 60870-5-1:1994 <i>Transmission frame formats</i>
EN 60870-5-2:1993 (IEC 870-5-2:1992)	BS EN 60870-5-2:1994 <i>Link transmission procedures</i>
EN 60870-5-3:1992 (IEC 870-5-3:1992)	BS EN 60870-5-3:1992 <i>Specification for general structure of application data</i>
EN 60870-5-4:1994 (IEC 870-5-4:1993)	BS EN 60870-5-4:1994 <i>Definition and coding of application information elements</i>
EN 60870-5-5:1996 (IEC 870-5-5:1995)	BS EN 60870-5-5:1996 <i>Basic application functions</i>
EN 60870-5-101:1996 (IEC 870-5-101:1995)	BS EN 60870-5-101:1996 <i>Companion standard for basic telecontrol tasks</i>
ISO/IEC 8482:1993	BS ISO/IEC 8482:1994 <i>Information technology. Telecommunications and information exchange between systems. Twisted pair multi point interconnections</i>

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 48, 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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English version

Telecontrol equipment and systems
Part 5: Transmission protocols
Section 102: Companion standard for the transmission of
integrated totals in electric power systems

(IEC 870-5-102:1996)

Matériels et systèmes de téléconduite
Partie 5: Protocoles de transmission
Section 102: Norme d'accompagnement pour la
transmission de totaux intégrés dans un
système électrique de puissance
(CEI 870-5-102:1996)

Fernwirkleinrichtungen und -systeme
Teil 5: Übertragungsprotokolle
Hauptabschnitt 102: Anwendungsbezogene
Norm für die Zählerstandsübertragung in der
Elektrizität
(IEC 870-5-102:1996)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
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Foreword

The text of document 57/254/FDIS, future edition 1 of IEC 870-5-102, prepared by IEC TC 57, Power system control and associated communications, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60870-5-102 on 1996-07-02.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1997-04-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1997-04-01

Annexes designated “normative” are part of the body of the standard. Annexes designated “informative” are given for information only. In this standard annex ZA is normative and annexes A and B are informative. Annex ZA has been added by CENELEC.

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Introduction

This section of IEC 870-5 serves as a companion standard for the transmission of integrated totals in electric power systems based on the series of international standards IEC 870-5.

1 Scope and object

The purpose of this section of IEC 870-5 is to standardize the transmission of integrated totals representing the amount of electrical energy transferred between power utilities, or between a power utility and independent producers on a high voltage (HV) or medium voltage (MV) network as a part of EMS (energy management systems) functionality. This section is not concerned with the low voltage (LV) networks or the interfaces to the energy consumption meters themselves.

In general the values of integrated totals are transmitted at periodic intervals to update the energy interchanged between utilities or between heavy industry and utilities. The periodically received information is used for supervisory and control purposes of energy distribution in wide area networks. The defined data transmission protocol specifies particular means of security against corruption of the transmitted application data from source to destination. Upgraded provisions of data integrity are desirable because interchange accounting may be based on the correct transfer of this information.

Standards specified in this section of IEC 870-5 are compatible with standards defined in IEC 870-5-1 to IEC 870-5-5 (see clause 2).

2 Normative references

The following normative documents 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 normative documents 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 normative documents 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 one: General principles*.

IEC 870-1-3:1990, *Telecontrol equipment and systems — Part 1: General considerations — Section three: Glossary*.

IEC 870-1-4:1994, *Telecontrol equipment and systems — Part 1: General considerations — Section 4: Basic aspects of telecontrol data transmission and organization of standards of IEC 870-5 and IEC 870-6*.

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

IEC 870-5-2:1992, *Telecontrol equipment and systems — Part 5: Transmission protocols — Section 2: Link transmission procedures*.

IEC 870-5-3:1992, *Telecontrol equipment and systems — Part 5: Transmission protocols — Section 3: General structure of application data*.

IEC 870-5-4:1993, *Telecontrol equipment and systems — Part 5: Transmission protocols — Section 4: Definition and coding of application information elements*.

IEC 870-5-5:1995, *Telecontrol equipment and systems — Part 5: Transmission protocols — Section 5: Basic application functions*.

IEC 870-5-101:1995, *Telecontrol equipment and systems — Part 5: Transmission protocols — Section 101: Companion standard for basic telecontrol tasks*.

ISO/IEC 8482:1993, *Information technology — Telecommunications and information exchange between systems — Twisted pair multipoint interconnections*.

ITU-T V.24:1994, *List of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE)*.

ITU-T V.28:1994, *Electrical characteristics for unbalanced double-current interchange circuits*.

3 Definitions

For the purpose of this section of IEC 870-5, the following definitions apply.

3.1

companion standard

a companion standard adds semantics to the definitions of the basic standard or a functional profile. This may be expressed by defining particular uses for information objects or by defining additional information objects, service procedures and parameters of the basic standard

NOTE Companion standards do not alter the standards to which they refer, but make explicit the relationship between those used together for a specific domain of activity.

3.2

integrated total; counter reading

the integral of a quantity over a time

3.3

integrated total data terminal equipment

equipment which updates integrated totals of energy interchange at transfer points of energy flow and presents this information for transmission to remote locations

3.4

record address of integration period

identification of particular integration periods

3.5

date of standard

the date of the release of a companion standard

3.6

signature

the arithmetic sum modulo 256 over all octets of an integrated total and its associated identification field

3.7

control direction

the direction of transmission from the controlling station to a controlled station

3.8

monitor direction

the direction of transmission from a controlled station to the controlling station

4 Protocol structure

The IEC 870-5 protocol is based on the three-layer reference model “ENHANCED PERFORMANCE ARCHITECTURE” (EPA), as specified in clause 4 of IEC 870-5-3.

The physical layer uses ITU-T recommendations that provide binary symmetric and memoryless transmission on the required medium in order to preserve the high level of data integrity of the defined block encoding method in the link layer.

The link layer consists of a number of link transmission procedures using explicit LINK PROTOCOL CONTROL INFORMATION (LPCI) that are capable of carrying APPLICATION SERVICE DATA UNITS (ASDUs) as link-user data. The link layer uses a selection of frame formats to provide the required integrity/efficiency and convenience of transmission.

The application layer contains a number of application functions that involve the transmission of ASDUs between source and destination.

The application layer of this companion standard does not use explicit APPLICATION PROTOCOL CONTROL INFORMATION (APCI). This is implicit in the contents of the ASDU DATA UNIT IDENTIFIER field and in the type of link service used.

Figure 1 shows the EPA model and the selected standard definitions of the companion standard.

Selected application functions of IEC 870-5-5	User process
Selected application information elements of IEC 870-5-4	Application (layer 7)
Selected application service data units of IEC 870-5-3	
Selected link transmission procedures of IEC 870-5-2	Link (layer 2)
Selected transmission frame formats of IEC 870-5-1	
Selected ITU-T recommendations	Physical (layer 1)
Figure 1 — Selected standards of this companion standard for transmission of integrated totals	

5 Physical layer

5.1 Selections from ISO and ITU-T recommendations

The following fixed network configurations are supported:

- point-to-point;
- multiple point-to-point;
- multipoint-star;
- multipoint-partyline;
- dialled point-to-point.

The subset of ITU-T recommendations V.24/V.28, defined in 5.1.1, is valid.

In case of digital transmission methods using digital signal multiplexers the X.24/X.27 interface may be used for channels up to 64 kbit/s by special agreement (see 5.1.2).

In this companion standard the data circuit is treated separately from the integrated total data terminal equipment (DTE) because it is often implemented by separate hardware. Consequently the companion standard includes a full specification of the DTE/DCE (data circuit terminating equipment) interface but only a requirement specification for suitable DCEs is given.

5.1.1 Unbalanced interchange circuit V.24/V.28

This companion standard specifies a subset of the ITU-T recommendation V.24, using the signal levels specified by recommendation V.28.

The standard transmission speeds may be specified for the directions of transmission and reception separately. The following choice of standard transmission speeds of the V.24/V.28 FSK-interface are supported:

100 bit/s	200 bit/s
300 bit/s	600 bit/s
1,2 kbit/s	

The standard transmission speeds of the V.24/V.28 MODEM-interface are:

300 bit/s	600 bit/s
1,2 kbit/s	2,4 kbit/s
4,8 kbit/s	9,6 kbit/s

Data transmission methods that are used to increase the exploitation of the bandwidth of a given transmission channel should be avoided unless it can be proven that the used method (that usually violates the required memoryless channel encoding principle) does not reduce the data integrity of the data block encoding method of the frame format FT 1.2.

5.1.2 Balanced interchange circuit X.24/X.27

Table 2 shows the balanced interchange circuit X.24/X.27 (used synchronously) to digital signal multiplexers. The interface that is operated with symmetric difference signals is suited for 64 kbit/s.

Table 1 — Selections from V.24/V.28

Interchange circuit number	Interchange circuit name	From DCE	To DCE
102	Signal ground or common return	—	—
103	Transmitted data		X
104	Received data	X	
105 ^a	Request to send		X
106 ^b	Ready for sending	X	
107 ^b	Data set ready	X	
108 ^a	Data terminal ready		X
109 ^b	Data channel received line signal detector	X	

^a May have constant potential.
^b Not mandatory. It can be used to supervise the transmission circuit.

Table 2 — Selection from X.24/X.27 for interfaces to synchronous digital signal multiplexers

Interchange circuit number	Interchange circuit name	From DCE	To DCE
G	Signal ground or common return	—	—
T	Transmit		X
R	Receive	X	
C ^a	Control		X
I ^a	Indication	X	
S	Signal element timing	X	

^a Control and indication signals are dispensable if DTEs are connected to the digital signal multiplexer. The signals may, however, be used for supervisory purposes.

The standard transmission speeds may be specified for the directions of transmission and reception separately.

The standard transmission speeds are:

2,4 kbit/s	4,8 kbit/s
9,6 kbit/s	19,2 kbit/s
38,4 kbit/s	56 kbit/s
64 kbit/s	

5.1.3 Other compatible interfaces

Other interfaces such as ISO 8482 or interfaces to fibre optics, etc, are permitted by agreement between vendor and user.

6 Link layer

The following standards are valid:

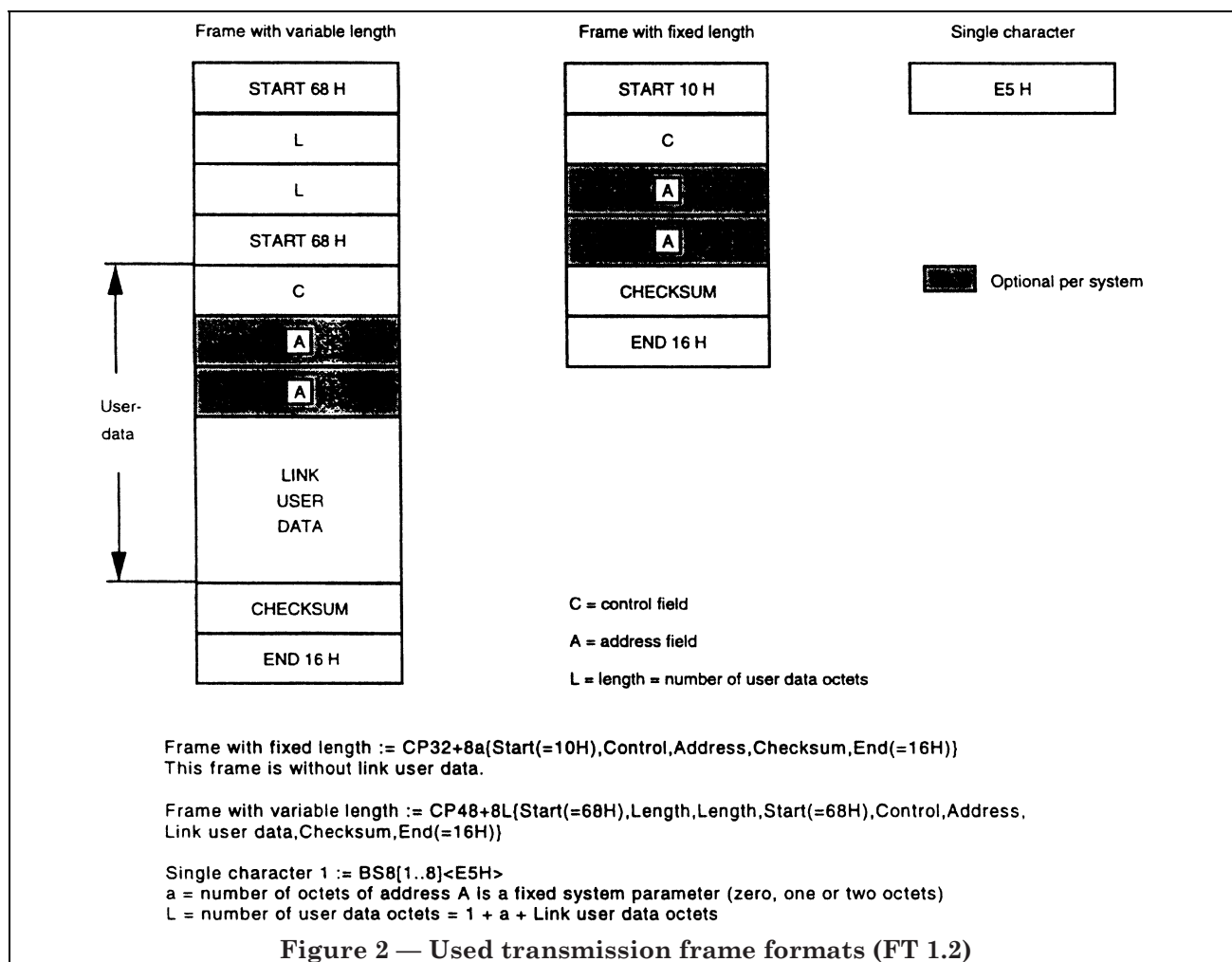
- IEC 870-5-1;
- IEC 870-5-2.

6.1 Selections from IEC 870-5-1 (transmission frame formats)

This companion standard admits exclusively frame format FT 1.2 that is defined in 6.2.4.2. Formats with fixed and with variable block length are admitted. Also the single control character 1 transmission is admitted.

NOTE 1 The rules defined in 6.2.4.2 have to be completely observed.

NOTE 2 The FT 1.2 frame is basically asynchronous, with the timing of each constituent 11-bit character, starting with its first bit and stopping with its last bit. However, when used with the synchronous interface, defined in 5.1.2 above, the signal element timing is derived from the DCE and runs continuously. In this case the frame has to be transmitted and received isochronously.



6.2 Selections from IEC 870-5-2 (link transmission procedures)

Only unbalanced transmission procedures as defined in clause 5 of IEC 870-5-2 are used. This means that the initiation of transmission procedures is limited to a fixed location (primary or master station) while the integrated total data terminal equipment is located in counter stations that are permanently secondary stations.

In hierarchical systems any intermediate nodes are primary in direction of the outstation and secondary in direction of the control centre.

The basic polling procedure uses the REQUEST/RESPOND-service with function code 11 to request user data class 2. Class 1 data are indicated by the ACD-bit as defined in IEC 870-5-2. Integrated totals of the latest period are declared as class 2 data, while integrated totals that were memorized in earlier time periods and all information that is requested by read-ASDUs are declared as class 1 data. The polling procedure of integrated totals is shown in 7.4.3. The interface between the link layer and the service user is not defined in this companion standard.

LINK LENGTH field (see 5.1.1 of IEC 870-5-2 and Figure 2 above)

The maximum length of link frames is set as a fixed system parameter. If required, the maximum length for each direction may be different.

The frame with fixed length has no link user data.

LINK CONTROL field (see 5.1.2 of IEC 870-5-2 and Figure 2 above)

The following function codes of the control field defined in Tables 1 and 2 of IEC 870-5-2 are admitted:

- frames sent from primary station (PRM = 1): 0, 3, 9, 10, 11;
- frames sent from secondary station (PRM = 0): 0, 1, 8, 9, 11;
- the reserve bit (RES:=BS1[8]) of the control field is not used and set to zero.

LINK ADDRESS field (see 5.1.3 of IEC 870-5-2 and Figure 2 above)

The address field A of the link (if present) is either one or two octets as determined by a fixed system parameter.

Alternative 1 (a = 1) Address = A := UI8[1..8]<0..255>

Alternative 2 (a = 2) Address = A := UI16[1..16]<0..65535>

There are no group addresses defined.

In polling systems the basic transmission procedure uses the REQUEST/RESPOND service function code 11 (request user data class 2). Class 1 data are indicated via the ACD-bit as defined in IEC 870-5-2.

Outstations that have no class 2 data shall respond to the class 2 request with the function code 9 for requested data not available.

Time out interval for repeated frame transmission

The matched time out interval as described in Figure A.2, case 2 in annex A of IEC 870-5-2 is not used. The time out interval which is specified in Figure A.2, case 1 is applicable. The time out interval t_0 is constant for each defined combination of transmission speeds and set by a parameter in 10 ms steps.

7 Application layer and user process

This companion standard selects specific structures of application data, information field elements and application functions defined in the following standards:

- IEC 870-5-3;
- IEC 870-5-4;
- IEC 870-5-5.

7.1 Selections from IEC 870-5-3 (general structure of application data)

IEC 870-5-3 describes the basic application data units in transmission frames of telecontrol systems. This subclause selects specific field elements out of this basic standard and defines the ASDUs used in this companion standard.

A LINK PROTOCOL DATA UNIT (LPDU) of this companion standard contains no more than one ASDU.

The ASDU (see Figure 3) is composed of a DATA UNIT IDENTIFIER and one or more than one INFORMATION OBJECTS.

The DATA UNIT IDENTIFIER has always the same structure for all ASDUs. The INFORMATION OBJECTS of an ASDU are always of the same structure and type, which are defined in the TYPE IDENTIFICATION field.

The structure of the DATA UNIT IDENTIFIER is

- one octet TYPE IDENTIFICATION;
- one octet VARIABLE STRUCTURE QUALIFIER;
- one octet CAUSE OF TRANSMISSION;
- two or three octets COMMON ADDRESS OF ASDU.

The COMMON ADDRESS OF ASDU is structured into two parts: the address of the integrated total data terminal equipment and the record address. The size of the address of the integrated total data terminal equipment is determined by a fixed system parameter, in this case one or two octets. The address of the integrated total data terminal equipment is the station address.

There is no data field LENGTH OF ASDU. Each frame has only a single ASDU available. The LENGTH OF ASDU is determined by the frame length (as announced in the link protocol length field) minus a fixed integer specified by a system parameter (which is 1, 2 or 3 depending on the length of the fixed link address field).

TIME TAGS (if present) belong either to a SINGLE INFORMATION OBJECT (TIME TAG OF INFORMATION OBJECT) or to the complete ASDU (COMMON TIME TAG OF ASDU).

The INFORMATION OBJECT consists of an INFORMATION OBJECT IDENTIFIER (if present), a SET OF INFORMATION ELEMENTS and, if present, a TIME TAG OF INFORMATION OBJECT.

The INFORMATION OBJECT IDENTIFIER consists only of the INFORMATION OBJECT ADDRESS. In most cases the COMMON ADDRESS OF ASDU together with the INFORMATION OBJECT ADDRESS distinguishes the complete SET OF INFORMATION ELEMENTS within a specific system. The combination of both addresses shall be unambiguous per system. The TYPE IDENTIFICATION is not a part of a COMMON ADDRESS or an INFORMATION OBJECT ADDRESS.

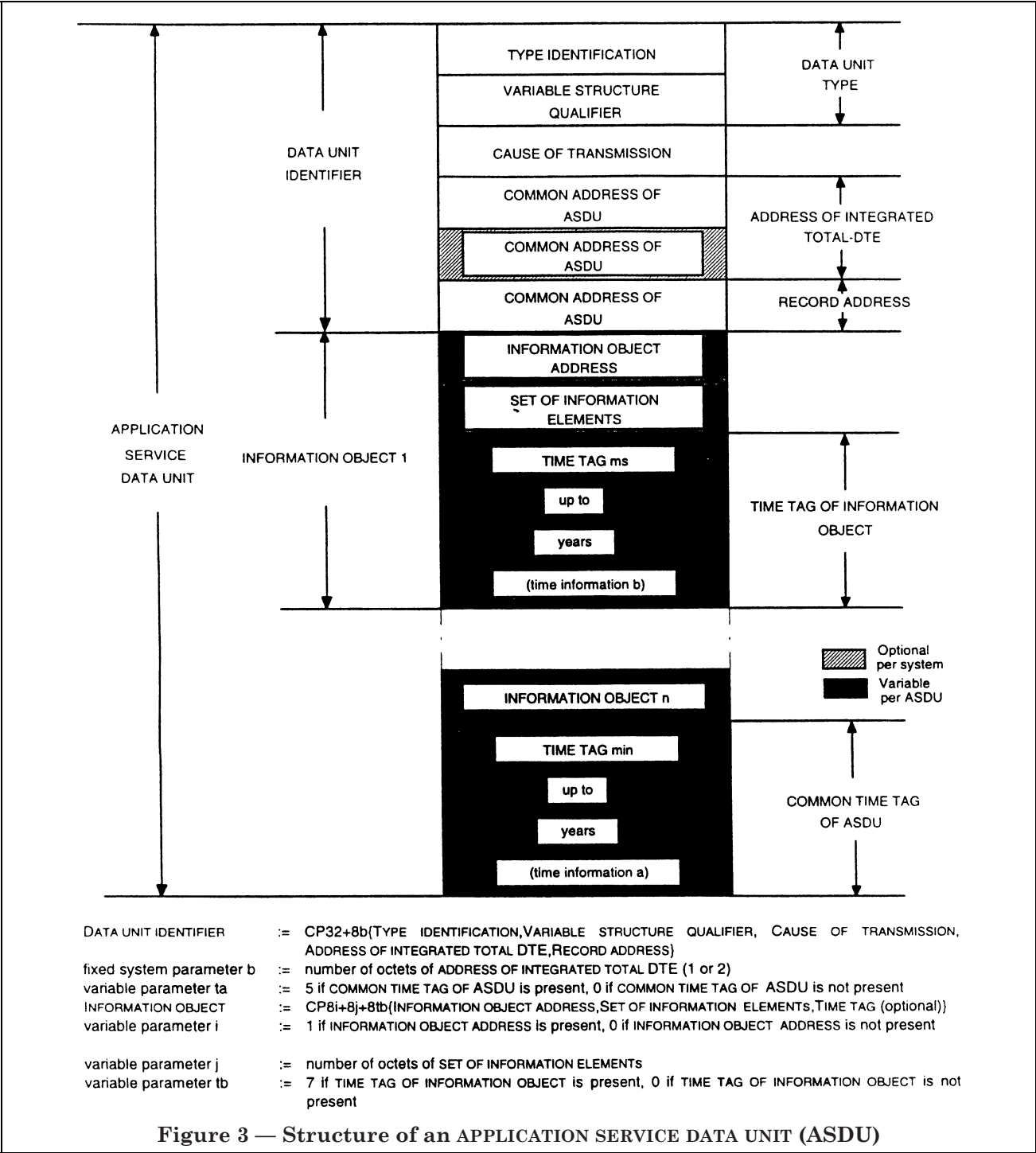


Figure 3 — Structure of an APPLICATION SERVICE DATA UNIT (ASDU)

Table 3 — Semantics of TYPE IDENTIFICATION – Process information in monitor direction

TYPE IDENTIFICATION	:=	UI8[1..8]<0..69>	
<0>	:=	Not defined	
<1>	:=	Single-point information with time tag	M_SP_TA_2
<2>	:=	Accounting integrated totals, four octets each	M_IT_TA_2
<3>	:=	Accounting integrated totals, three octets each	M_IT_TB_2
<4>	:=	Accounting integrated totals, two octets each	M_IT_TC_2
<5>	:=	Periodically reset accounting integrated totals, four octets each	M_IT_TD_2
<6>	:=	Periodically reset accounting integrated totals, three octets each	M_IT_TE_2
<7>	:=	Periodically reset accounting integrated totals, two octets each	M_IT_TF_2
<8>	:=	Operational integrated totals, four octets each	M_IT_TG_2
<9>	:=	Operational integrated totals, three octets each	M_IT_TH_2
<10>	:=	Operational integrated totals, two octets each	M_IT_TI_2
<11>	:=	Periodically reset operational integrated totals, four octets each	M_IT_TK_2
<12>	:=	Periodically reset operational integrated totals, three octets each	M_IT_TL_2
<13>	:=	Periodically reset operational integrated totals, two octets each	M_IT_TM_2
<14..69>	:=	reserved for further compatible definitions	

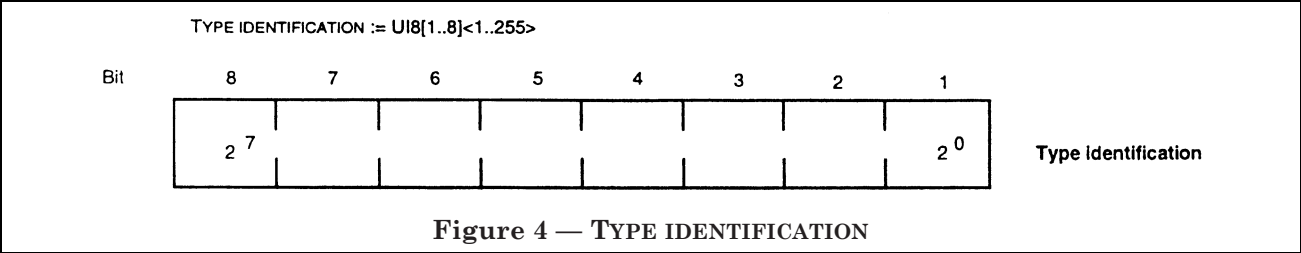
The SET OF INFORMATION ELEMENTS may be either a SINGLE INFORMATION ELEMENT, a COMBINATION OF ELEMENTS or a SEQUENCE OF INFORMATION ELEMENTS.

7.2 Selections from IEC 870-5-4 (definition and coding of application information elements)

The sizes and the contents of individual information fields of ASDUs are specified according to the declaration rules for information elements defined in IEC 870-5-4.

7.2.1 Type identification

Octet 1, TYPE IDENTIFICATION defines structure, type and format of the following INFORMATION OBJECT(s). TYPE IDENTIFICATION is defined as:



INFORMATION OBJECTS with or without TIME TAGS are distinguished with different numbers of the TYPE IDENTIFICATION.

ASDUs with undefined values of TYPE IDENTIFICATION are acknowledged negatively and discarded by both controlling and controlled stations.

7.2.1.1 Definition of the semantics of the values of the type identification field

The value <0> is not used. The range of values (numbers) 1 to 127 is defined in this companion standard. The range of numbers 128 to 255 is not defined. TYPE IDENTIFICATION numbers 128 to 255 may be defined independently of each other by users of this standard. However full interoperability would then be obtained only when using ASDUs having TYPE IDENTIFICATIONS in the range 1 to 127.

The following tables show the definition of TYPE IDENTIFICATION numbers for process- and system information in monitor and control direction.

TYPE IDENTIFICATION := UI8[1..8]<1..255>

- <1..127> := for standard definitions of this companion standard (compatible range)
- <128..255> := for special use (private range)

Table 4 — Semantics of TYPE IDENTIFICATION – System information in monitor direction

TYPE IDENTIFICATION	:=	UI8[1..8]<70..99>	
<70>	:=	End of initialization	M_EI_NA_2
<71>	:=	Manufacturer and product specification of integrated total DTE	P_MP_NA_2
<72>	:=	Current system time of integrated total DTE	M_TI_TA_2
<73..99>	:=	reserved for further compatible definitions	

Table 5 — Semantics of TYPE IDENTIFICATION – System information in control direction

TYPE IDENTIFICATION	:=	UI8[1..8]<100..127>	
CON<100>	:=	Read manufacturer and product specification	C_RD_NA_2
CON<101>	:=	Read record of single-point information with time tag	C_SP_NA_2
CON<102>	:=	Read record of single-point information with time tag of a selected time range	C_SP_NB_2
CON<103>	:=	Read current system time of integrated total DTE	C_TI_NA_2
CON<104>	:=	Read accounting integrated totals of the oldest integration period	C_CI_NA_2
CON<105>	:=	Read accounting integrated totals of the oldest integration period and of a selected range of addresses	C_CI_NB_2
CON<106>	:=	Read accounting integrated totals of a specific past integration period	C_CI_NC_2
CON<107>	:=	Read accounting integrated totals of a specific past integration period and of a selected range of addresses	C_CI_ND_2
CON<108>	:=	Read periodically reset accounting integrated totals of the oldest integration period	C_CI_NE_2
CON<109>	:=	Read periodically reset accounting integrated totals of the oldest integration period and of a selected range of addresses	C_CI_NF_2
CON<110>	:=	Read periodically reset accounting integrated totals of a specific past integration period	C_CI_NG_2
CON<111>	:=	Read periodically reset accounting integrated totals of a specific past integration period and of a selected range of addresses	C_CI_NH_2
CON<112>	:=	Read operational integrated totals of the oldest integration period	C_CI_NI_2
CON<113>	:=	Read operational integrated totals of the oldest integration period and of a selected range of addresses	C_CI_NK_2
CON<114>	:=	Read operational integrated totals of a specific past integration period	C_CI_NL_2
CON<115>	:=	Read operational integrated totals of a specific past integration period and of a selected range of addresses	C_CI_NM_2
CON<116>	:=	Read periodically reset operational integrated totals of the oldest integration period	C_CI>NN_2
CON<117>	:=	Read periodically reset operational integrated totals of the oldest integration period and of a selected range of addresses	C_CI_NO_2
CON<118>	:=	Read periodically reset operational integrated totals of a specific past integration period	C_CI_NP_2
CON<119>	:=	Read periodically reset operational integrated totals of a specific past integration period and of a selected range of addresses	C_CI_NQ_2
CON<120>	:=	Read accounting integrated totals of a selected time range and of a selected range of addresses	C_CI_NR_2
CON<121>	:=	Read periodically reset accounting integrated totals of a selected time range and of a selected range of addresses	C_CI_NS_2
CON<122>	:=	Read operational integrated totals of a selected time range and of a selected range of addresses	C_CI_NT_2
CON<123>	:=	Read periodically reset operational integrated totals of a selected time range and of a selected range of addresses	C_CI_NU_2
<124..127>	:=	reserved for further compatible definitions	