

Distribution automation using distribution line carrier systems —

Part 6: A-XDR encoding rule

The European Standard EN 61334-6:2000 has the status of a British Standard

ICS 29.240.99; 33.040.40

National foreword

This British Standard is the official English language version of EN 61334-6:2000. It is identical with IEC 61334-6:2000.

The UK participation in its preparation was entrusted to Technical Committee PEL/57, Power system control and associated communications, which has the responsibility to:

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 39 and a back cover.

The BSI copyright date displayed in this document indicates when the document was last issued.

Amendments issued since publication

Amd. No.	Date	Comments

© BSI 06-2001

ISBN 0 580 37387 8

EUROPEAN STANDARD

EN 61334-6

NORME EUROPÉENNE

EUROPÄISCHE NORM

November 2000

ICS 29.240.20;33.200

English version

Distribution automation using distribution line carrier systems
Part 6: A-XDR encoding rule
(IEC 61334-6:2000)

Automatisation de la distribution
à l'aide de systèmes de communication
à courants porteurs
Partie 6: Règles d'encodage A-XDR
(CEI 61334-6:2000)

Verteilungsautomatisierung
mit Hilfe von Trägersystemen auf
Verteilungsleitungen
Teil 6: A-XDR-Codierungsregel
(IEC 61334-6:2000)

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

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Foreword

The text of document 57/451/FDIS, future edition 1 of IEC 61334-6, 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 61334-6 on 2000-08-01.

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) 2001-05-01
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2003-08-01

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, B and C are informative.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61334-6:2000 was approved by CENELEC as a European Standard without any modification.

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INTRODUCTION

ITU-T Recommendation X.208 specifies a formal language (ASN.1 = Abstract Syntax Notation One) which enables application layer specifications to define the types¹⁾ of information they need to exchange. A representation of this information can be derived by applying a set of encoding rules to values of types defined using the ASN.1 notation. Application of these encoding rules produces a transfer syntax for such values.

Although many such sets of encoding rules could be imagined, for a long time only one single set – the BER = Basic Encoding Rules – has been standardized (see ITU-T Recommendation X.209). This is mainly because BER is quite adequate for a wide range of applications. On the other hand, in some particular cases, BER can obviously be redundant. Avoiding this redundancy by providing alternative encoding rules for those particular cases is the scope of some recently developed new transfer syntax standards (DER, CER, PER). Clearly, the aim is not to provide general-purpose, but rather specialized, alternatives to the BER, which are more suitable than the BER in some respects.

Contrary to these general-purpose encoding rules, this standard specifies a new, special-purpose set of encoding rules – A-XDR – which fits in best with the DLMS context (see IEC 61334-4-41). The principal objective is to encode DLMS PDUs in such a way that the PDUs byte count and encoding/decoding complexity – the length of the required code, its processing performance and time – are optimized²⁾. This objective is fulfilled by two basic principles.

- a) A-XDR specifies encoding rules only for a subset of ASN.1 types: for the subset which is used for the DLMS specification. (That is why A-XDR is special-purpose.)
- b) A-XDR specifies byte-oriented encoding rules.

1) ASN.1 also specifies a notation for the specification of the value of a defined type.

2) With respect to the PDU size only, PER over-performs A-XDR. However, this better compacting performance – the principal objective of PER – is achieved by a much more extensive use of bit fields instead of byte fields to encode different values. To reduce encoding sizes further, the more complex PER variant (the Unaligned PER) also benefits from the limitation of values of constrained types. Gain on compactness is thus obtained at the expense of computational overhead. Furthermore, PER comes with two, incompatible variants (Aligned and Unaligned), and it is recommended that implementations should support both of them. This complexity means that PER is not optimal for the DLMS context. The 'lighter-weight' A-XDR encoding rules are more suitable to that simple environment, which is in some cases very poor in resources.

DISTRIBUTION AUTOMATION USING DISTRIBUTION LINE CARRIER SYSTEMS –

Part 6: A-XDR encoding rule

1 Scope and object

This part of IEC 61334 defines a set of encoding rules – the A-XDR³⁾ encoding rules – that may be used to derive the specification of a transfer syntax for values of types defined in the DLMS core standard using the ASN.1 notation (see IEC 61334-4-41). These A-XDR encoding rules are also to be applied for decoding such a transfer syntax in order to identify the data values being transferred.

The A-XDR encoding rules

- are used at the time of communication;
- provide optimal⁴⁾ encoding for DLMS PDUs.

NOTE Provided that A-XDR ensures optimal encoding for DLMS PDUs, it is intended to be the default encoding rule for DLMS-based communication protocols. Nevertheless, the default – and also the possibly usable optional – encoding rules will be specified in the Application Layer document of the given protocol (for example, IEC 61334-4-42), as part of the Application context.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61334. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 61334 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

IEC 61334-4-41:1996, *Distribution automation using distribution line carrier systems – Part 4: Data communication protocols – Section 41: Application protocols – Distribution line message specification*

IEC 61334-4-42:1996, *Distribution automation using distribution line carrier systems – Part 4: Data communication protocols – Section 42: Application protocols – Application layer*

ISO/IEC 8825-2:1997, *Information technology – ASN.1 Encoding rules: Specification of packed encoding rules (PER)*

ITU-T Recommendation X.208:1988, *Specification of Abstract Syntax Notation One (ASN.1)*

ITU-T Recommendation X.209:1988, *Specification of basic encoding rules for Abstract Syntax Notation One (ASN.1)*

³⁾ A-XDR stands for Adapted XDR. In fact, these encoding rules are derived from a proven and *de facto* standard of the Unix world, called XDR (eXternal Data Representation, rfc1014).

⁴⁾ See footnote 2 of the introduction.

3 General characteristics of A-XDR

A-XDR specifies encoding rules which can be used to encode and decode the values of an abstract syntax defined as the values of a single ASN.1 type (the outermost type). This single ASN.1 type is either a simple type or a composite type. A component of a composite type may be a simple type or a composite type itself.

The A-XDR encoding rules exploit the fact that the sender and the receiver of a DLMS PDU are operating exactly the same specification of the abstract syntax. While with BER the encoding of every value of any type of abstract syntax is constructed in type-length-value (TLV) style, A-XDR encodes the type and the length of the value only when this information is necessary. This implies that without knowledge of the type of value encoded it is not possible to determine the structure of the encoding.

NOTE This encoding method gives the result that A-XDR encoding rules are not extensible (see annex A).

In order to keep A-XDR as simple as possible, some restrictions apply with respect to the abstract syntax to be encoded as follows:

- no encoding support is provided for ASN.1 types which are not used in DLMS⁵⁾;
- the CHOICE ASN.1 type should contain only explicitly⁶⁾ tagged components.

A-XDR specifies byte-oriented encoding rules. This means that each part of the encoding – and therefore also the encoding of the whole – is an integral number of bytes.

4 Structure of an encoding

The basis of BER encoding (see ITU-T Recommendation X.209) is a structure, made up of three parts: type, length and value, as shown in figure 1. In BER, these three parts are termed identifier (I), length (L) and contents (C). The identifier part identifies the type, the length part allows the end of the contents⁷⁾ to be found, and the contents part conveys one of the possible values of that type.



IEC 730/2000

Figure 1 – The basic BER structure

The contents field can be simply a series of bytes⁸⁾ (primitive encoding) or a series of nested encoding (constructed encoding), as shown in figure 2.

5) Annex B enumerates the ASN.1 types and keywords which are used in the DLMS specification.

6) The terms "explicit tagging" and "implicit tagging" have a slightly different meaning in A-XDR than that specified for ASN.1 and BER. Subclause 6.7 deals with these notions and also introduces the new "ASN.1 explicit tagging" term.

7) In fact, for BER, the length field does not always literally represent the length of the contents. BER specifies two forms (definite and indefinite) of the length field. Although, when the definite form is used, the length field effectively represents the number of bytes in the contents field, for the indefinite form the length field indicates that the contents are terminated by end-of-contents bytes.

8) Zero or more.

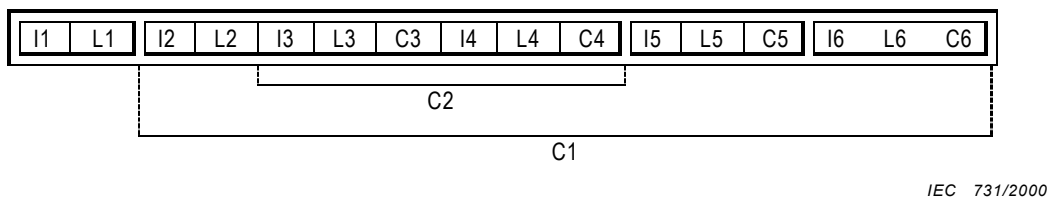


Figure 2 – The structure of a constructed BER encoding

The nesting can be as deep as needed and stops either with a primitive encoding or with a constructed encoding with empty contents.

A-XDR is based upon the same encoding structure, but in order to benefit from the fact that the sender and the receiver of a DLMS PDU are operating exactly the same specification of the abstract syntax, A-XDR does not encode the Identifier (I) and/or the Length (L) fields when those fields convey redundant information (when not to encode one or both of these fields does not result in uninterpretable, ambiguous encoding). A constructed A-XDR encoding therefore results in a structure as shown in figure 3.

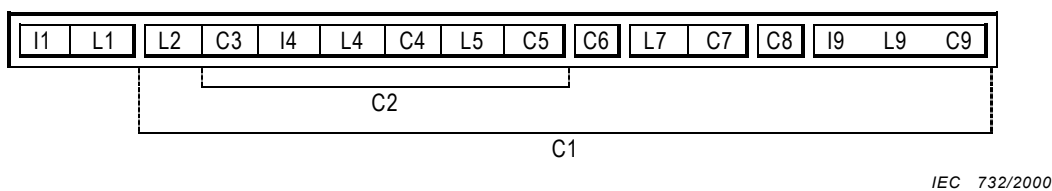


Figure 3 – The structure of a constructed A-XDR encoding

A-XDR encoding rules specify

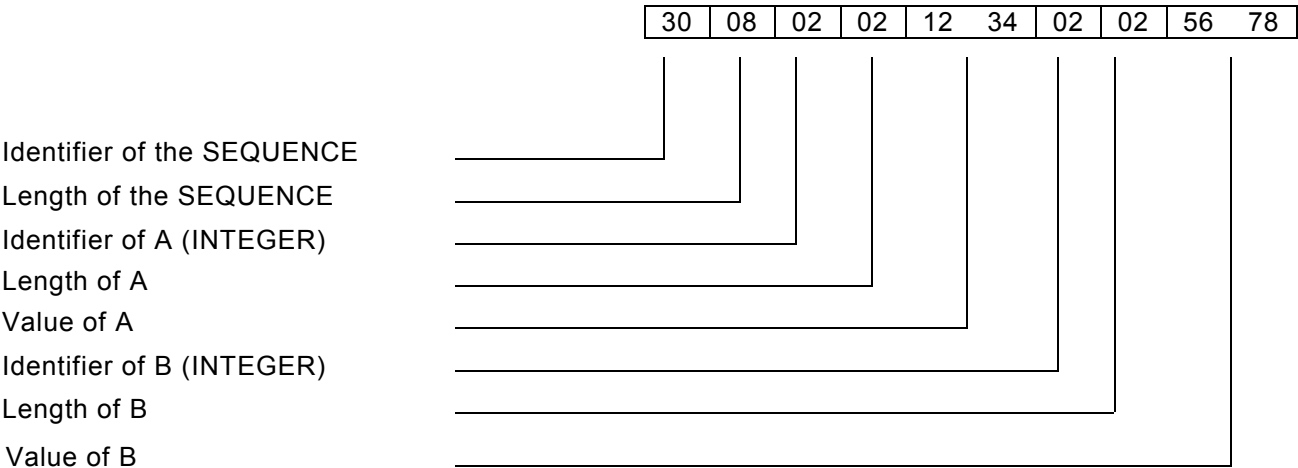
- encoding rules for the contents fields;
- the conditions when the L field should be present, and the encoding of that field;
- the conditions when the I field should be present, and the encoding of that field.

Example

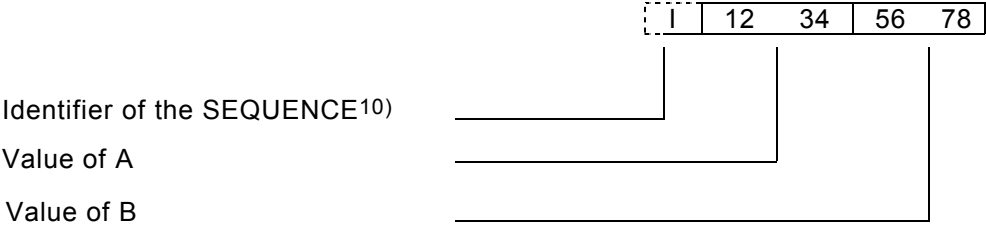
Taking the following ASN.1 composite type:

```
value ::= SEQUENCE {
    A      Integer16,
    B      Unsigned16
}
Integer16 ::= INTEGER(−32768..32767)
Unsigned16 ::= INTEGER(0..32767)
```

and supposing that the values to be encoded for A and for B are 0x1234 and 0x5678⁹⁾ respectively, the BER encoding of that sequence may result in the following series of bytes:



A-XDR encoding of the same sequence is as follows:



⁹⁾ The term 0x... indicates that the following digits represent hexadecimal digits.

¹⁰⁾ A-XDR requires encoding identifier only in special cases (for example, when the SEQUENCE of this example is one of the choices of a CHOICE type).

5 Rules for encoding

A-XDR encoding of any ASN.1 type results in an integral number of bytes, each containing eight bits. This series of bytes begins with the first byte of the encoding of the Identifier field of the outermost ASN.1 type – in these terms, this byte can be considered as the most significant byte. For the purpose of this standard, the following identification schema applies:

- the bytes of the A-XDR encoding are not systematically numbered, but sometimes, when it helps for clear understanding, comments apply (for example, 1 byte of the value, etc.);
- bits of any byte are numbered from 1 to 8, where bit 8 is the most significant.

5.1 The Identifier field

The purpose of the Identifier field is to indicate the type of the encoded value. Provided that the sender and the receiver are operating exactly the same specification of the abstract syntax, the Identifier field conveys information only in cases when

- a) one type of data should be selected between different alternatives – CHOICE;
- b) the presence of an OPTIONAL component in a SEQUENCE type should be indicated;
- c) the presence of a DEFAULT component in a SEQUENCE type should be indicated.

A-XDR encoding contains an Identifier field only in these cases. In addition, A-XDR encodes an Identifier when encoding the Identifier is required by the ASN.1 specification (ASN.1 explicit tagging, see 6.7).

In case a), A-XDR requires that all the alternatives of the CHOICE will be specified at ASN.1 level as explicitly tagged types (see 6.7). In these cases, the encoded tag forms the identifier field.

In cases b) and c), the presence or the absence of the OPTIONAL or DEFAULT component is indicated by a so-called BOOLEAN presence flag. The Identifier field for these component values is the A-XDR encoding of the value of the presence flag (see 6.9).

On the other hand, A-XDR may be forced to encode the Identifier field, when the ASN.1 definition contains ASN.1 explicit tags (see 6.7). A-XDR encoding of such types is defined to be the same as their BER encoding. The aim of this support is to force the length to be encoded, for example, in order to allow for the easy omission of some structures. The Identifier field for those types is the encoded value of the ASN.1 tag and occupies an integral number of bytes, at least one, as specified in ITU-T Recommendation X.209.

5.2 The Length field

In A-XDR the Length field (when this field is present) immediately precedes the Contents field, represents explicitly the length of the Contents field and occupies an integral number of bytes. Provided that the sender and the receiver are operating exactly the same specification of the abstract syntax, the Length field conveys information only in cases when a variable length ASN.1 type is to be encoded. The possible cases are

- a) variable length INTEGER;
- b) variable length BIT STRING;
- c) variable length BYTE STRING;
- d) variable length SEQUENCE OF type.

A-XDR encodes the Length field only in the above cases, and, in addition, in one more case, when it is required by the ASN.1 specification (ASN.1 explicit tagging, see 6.7).

In a), b), c) and d), the Length field is encoded as a variable length integer. For the additional case, the same encoding applies as defined in BER (see ITU-T Recommendation X.209) except for the restriction that only the definite form can be used. Using the indefinite form (footnote 7) for the Length field is not allowed within A-XDR.

5.3 The Contents field

The Contents field is the substance of the encoding, conveying the actual value. It consists of zero or more bytes, and shall encode the data value as specified in the following clauses.

6 Encoding procedures

6.1 Encoding of an INTEGER value

A-XDR provides two types of encoding for the ASN.1 INTEGER type, depending on whether the ASN.1 definition of an INTEGER is value-constrained or not. When an INTEGER is specified to be within a restricted range of values, for example INTEGER(−128..127), it is encoded as a *fixed-length integer*. Otherwise, when no range is specified, the INTEGER is encoded as a *variable-length integer*.

6.1.1 Encoding of a fixed-length integer value

Two different encodings are provided by A-XDR for fixed-length integers: integers which are specified to be within a non-negative value range are represented and encoded as *unsigned* binary numbers, while integers which may take negative values are represented and encoded as two's complement binary numbers. In both cases, only the value of the integer is encoded, forming the contents field of the encoding. The aim is to provide minimal-length encoding.

6.1.1.1 Encoding of fixed-length, unsigned integer values

When an INTEGER is specified to be within a non-negative value range, it is encoded as an unsigned binary number. The number of bytes of the encoding is determined by the specified value-range: it is equal to the minimum number of necessary bytes which is required to represent any value within the specified range. The range of a fixed-length unsigned integer is always aligned on byte boundary.

Example

INTEGER(0..255) is encoded in 1 byte
 INTEGER(0..256) is encoded in 2 bytes
 INTEGER(237..256) is encoded in 2 bytes

A fixed-length unsigned integer is presented in unsigned binary notation. The encoding is an unsigned binary number equal to the integer value and consists of bits 8 to 1 of the first byte, followed by bits 8 to 1 of the second byte, followed by bits 8 to 1 of each byte in turn, up to and including the last byte of the encoding.

Example

A-XDR encoding of the 61478 value of an INTEGER(0..65535) is as follows:

1 st byte	2 nd byte
8 7 6 5 4 3 2 1	8 7 6 5 4 3 2 1
1 1 1 1 0 0 0 0	0 0 1 0 0 1 1 0