INTERNATIONAL STANDARD

ISO/IEC 8825-1

Sixth edition
2021-06

Information technology — ASN.1 encoding rules —

Part 1: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)

Technologies de l'information — Règles de codage ASN.1 —

Partie 1: Spécification des règles de codage de base (BER), des règles de codage canoniques (CER) et des règles de codage distinctives (DER)

Reference number
ISO/IEC 8825-1:2021(E)

Documents
Document Sharing Hub

© ISO/IEC 2021

Full document details: ISO_IEC 8825-1_2021

COPYRIGHT PROTECTED DOCUMENT

© ISO/IEC 2021

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub

Full document details: ISO_IEC 8825-1_2021

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives or www.iec.ch/members_experts/refdocs)

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents) or the IEC list of patent declarations received (see patents.iec.ch).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html. In the IEC, see www.iec.ch/understanding-standards.

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 6, *Telecommunications and information exchange between systems,* in collaboration with ITU-T. The identical text is published as ITU-T X.690 (02/2021).

This sixth edition cancels and replaces the fifth edition (ISO/IEC 8825-1:2015), which has been technically revised.

A list of all parts in the ISO/IEC 8825 series can be found on the ISO and IEC websites.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: ISO_IEC 8825-1_2021

Documents
Document Sharing Hub

Full document details: ISO_IEC 8825-1_2021

CONTENTS

		Page
Introduction		v
1	Scope	1
2	Normative references	1
2.1	Identical Recommendations | International Standards	1
2.2	Additional references	1
3	Definitions	2
4	Abbreviations	2
5	Notation	3
6	Convention	3
7	Conformance	3
8	Basic encoding rules	3
8.1	General rules for encoding	3
8.1.1	Structure of an encoding	3
8.1.2	Identifier octets	4
8.1.3	Length octets	5
8.1.4	Contents octets	6
8.1.5	End-of-contents octets	6
8.2	Encoding of a boolean value	7
8.3	Encoding of an integer value	7
8.4	Encoding of an enumerated value	7
8.5	Encoding of a real value	7
8.6	Encoding of a bitstring value	9
8.7	Encoding of an octetstring value	10
8.8	Encoding of a null value	10
8.9	Encoding of a sequence value	10
8.10	Encoding of a sequence-of value	11
8.11	Encoding of a set value	11
8.12	Encoding of a set-of value	11
8.13	Encoding of a choice value	11
8.14	Encoding of a value of a prefixed type	11
8.15	Encoding of an open type	12
8.16	Encoding of an instance-of value	12
8.17	Encoding of a value of the embedded-pdv type	13
8.18	Encoding of a value of the external type	13
8.19	Encoding of an object identifier value	14
8.20	Encoding of a relative object identifier value	15
8.21	Encoding of an OID internationalized resource identifier value	15
8.22	Encoding of a relative OID internationalized resource identifier value	15
8.23	Encoding for values of the restricted character string types	15
8.24	Encoding for values of the unrestricted character string type	18
8.25	Encoding for values of the Useful Types	18
8.26	Encoding for values of the `TIME` type and the useful time types	18
8.26.1	Encoding for values of the `TIME` type	18
8.26.2	Encoding for values of the `DATE` type	18
8.26.3	Encoding for values of the `TIME-OF-DAY` type	18
8.26.4	Encoding for values of the `DATE-TIME` type	18
8.26.5	Encoding for values of the `DURATION` type	18

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: ISO_IEC 8825-1_2021

9 Canonical encoding rules 19
9.1 Length forms 19
9.2 String encoding forms 19
9.3 Set components 19
10 Distinguished encoding rules 19
10.1 Length forms 19
10.2 String encoding forms 20
10.3 Set components 20
11 Restrictions on BER employed by both CER and DER 20
11.1 Boolean values 20
11.2 Unused bits 20
11.3 Real values 20
11.4 GeneralString values 21
11.5 Set and sequence components with default value 21
11.6 Set-of components 21
11.7 GeneralizedTime 21
11.8 UTCTime 21
11.8.4 Examples of valid representations 22
11.8.5 Examples of invalid representations 22
11.9 The `TIME` type and the useful time types 22
12 Use of BER, CER and DER in transfer syntax definition 22
Annex A – Example of encodings 24
A.1 ASN.1 description of the record structure 24
A.2 ASN.1 description of a record value 24
A.3 Representation of this record value 24
Annex B – Identification of Encoding Rules 26
Annex C – Illustration of real value encoding 27

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: ISO_IEC 8825-1_2021

Introduction

Rec. ITU-T X.680 | ISO/IEC 8824-1, Rec. ITU-T X.681 | ISO/IEC 8824-2, Rec. ITU-T X.682 | ISO/IEC 8824-3, Rec. ITU-T X.683 | ISO/IEC 8824-4 (Abstract Syntax Notation One or ASN.1) together specify a notation for the definition of abstract syntaxes, enabling application standards to define the types of information they need to transfer. It also specifies a notation for the specification of values of a defined type.

This Recommendation | International Standard defines encoding rules that may be applied to values of types defined using the ASN.1 notation. Application of these encoding rules produces a transfer syntax for such values. It is implicit in the specification of these encoding rules that they are also to be used for decoding.

There may be more than one set of encoding rules that can be applied to values of types that are defined using the ASN.1 notation. This Recommendation | International Standard defines three sets of encoding rules, called *basic encoding rules*, *canonical encoding rules* and *distinguished encoding rules*. Whereas the basic encoding rules give the sender of an encoding various choices as to how data values may be encoded, the canonical and distinguished encoding rules select just one encoding from those allowed by the basic encoding rules, eliminating all of the sender's options. The canonical and distinguished encoding rules differ from each other in the set of restrictions that they place on the basic encoding rules.

The distinguished encoding rules is more suitable than the canonical encoding rules if the encoded value is small enough to fit into the available memory and there is a need to rapidly skip over some nested values. The canonical encoding rules is more suitable than the distinguished encoding rules if there is a need to encode values that are so large that they cannot readily fit into the available memory or it is necessary to encode and transmit a part of a value before the entire value is available. The basic encoding rules is more suitable than the canonical or distinguished encoding rules if the encoding contains a set value or set-of value and there is no need for the restrictions that the canonical and distinguished encoding rules impose. This is due to the memory and CPU overhead that the latter encoding rules exact in order to guarantee that set values and set-of values have just one possible encoding.

Annex A gives an example of the application of the basic encoding rules. It does not form an integral part of this Recommendation | International Standard.

Annex B summarizes the assignment of object identifier and OID internationalized resource identifier values made in this Recommendation | International Standard. It does not form an integral part of this Recommendation | International Standard.

Annex C gives examples of applying the basic encoding rules for encoding reals. It does not form an integral part of this Recommendation | International Standard.

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: ISO_IEC 8825-1_2021

Documents
Document Sharing Hub

Full document details: ISO_IEC 8825-1_2021

INTERNATIONAL STANDARD
ITU-T RECOMMENDATION

Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)

1 Scope

This Recommendation | International Standard specifies a set of basic encoding rules that may be used to derive the specification of a transfer syntax for values of types defined using the notation specified in Rec. ITU-T X.680 | ISO/IEC 8824-1, Rec. ITU-T X.681 | ISO/IEC 8824-2, Rec. ITU-T X.682 | ISO/IEC 8824-3, and Rec. ITU-T X.683 | ISO/IEC 8824-4, collectively referred to as Abstract Syntax Notation One or ASN.1. These basic encoding rules are also to be applied for decoding such a transfer syntax in order to identify the data values being transferred. It also specifies a set of canonical and distinguished encoding rules that restrict the encoding of values to just one of the alternatives provided by the basic encoding rules.

2 Normative references

The following Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this Recommendation | International Standard. At the time of publication, the editions indicated were valid. All Recommendations and Standards are subject to revision, and parties to agreements based on this Recommendation | International Standard are encouraged to investigate the possibility of applying the most recent edition of the Recommendations and Standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunication Standardization Bureau of the ITU maintains a list of currently valid ITU-T Recommendations.

NOTE – This Recommendation | International Standard is based on ISO/IEC 10646:2003. It cannot be applied using later versions of this standard.

2.1 Identical Recommendations | International Standards

- Recommendation ITU-T X.200 (1994) | ISO/IEC 7498-1: 1994, *Information technology – Open Systems Interconnection – Basic Reference Model: The basic model*.
- Recommendation ITU-T X.680 (2021) | ISO/IEC 8824-1:2021, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation.*
- Recommendation ITU-T X.681 (2021) | ISO/IEC 8824-2:2021, *Information technology – Abstract Syntax Notation One (ASN.1): Information object specification.*
- Recommendation ITU-T X.682 (2021) | ISO/IEC 8824-3:2021, *Information technology – Abstract Syntax Notation One (ASN.1): Constraint specification.*
- Recommendation ITU-T X.683 (2021) | ISO/IEC 8824-4:2021, *Information technology – Abstract Syntax Notation One (ASN.1): Parameterization of ASN.1 specifications.*

NOTE – The references above shall be interpreted as references to the identified Recommendations | International Standards together with all their published amendments and technical corrigenda.

2.2 Additional references

- ISO *International Register of Coded Character Sets to be used with Escape Sequences.*
- ISO/IEC 2022:1994, *Information technology – Character code structure and extension techniques.*
- ISO/IEC 2375:2003, *Information technology – Procedure for registration of escape sequences and coded character sets*.

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: ISO_IEC 8825-1_2021

– ISO 6093:1985, *Information processing – Representation of numerical values in character strings for information interchange.*

– ISO/IEC 6429:1992, *Information technology – Control functions for coded character sets.*

– ISO/IEC 10646:2003, *Information technology – Universal Multiple-Octet Coded Character Set (UCS).*

3 Definitions

For the purposes of this Recommendation | International Standard, the definitions of Rec. ITU-T X.200 | ISO/IEC 7498-1 and Rec. ITU-T X.680 | ISO/IEC 8824-1 and the following definitions apply.

3.1 canonical encoding: A complete encoding of an abstract value obtained by the application of encoding rules that have no implementation-dependent options. Such rules result in the definition of a 1-1 mapping between unambiguous and unique encodings and values in the abstract syntax.

3.2 constructed encoding: A data value encoding in which the contents octets are the complete encoding of one or more data values.

3.3 contents octets: That part of a data value encoding which represents a particular value, to distinguish it from other values of the same type.

3.4 data value: Information specified as the value of a type; the type and the value are defined using ASN.1.

3.5 dynamic conformance: A statement of the requirement for an implementation to adhere to the prescribed behaviour in an instance of communication.

3.6 encoding (of a data value): The complete sequence of octets used to represent the data value.

3.7 end-of-contents octets: Part of a data value encoding, occurring at its end, which is used to determine the end of the encoding.

NOTE – Not all encodings require end-of-contents octets.

3.8 identifier octets: Part of a data value encoding which is used to identify the type of the value.

NOTE – Some ITU-T Recommendations use the term "data element" for this sequence of octets, but the term is not used in this Recommendation | International Standard, as other Recommendations | International Standards use it to mean "data value".

3.9 length octets: Part of a data value encoding following the identifier octets which is used to determine the end of the encoding.

3.10 primitive encoding: A data value encoding in which the contents octets directly represent the value.

3.11 receiver: An implementation decoding the octets produced by a sender, in order to identify the data value which was encoded.

3.12 sender: An implementation encoding a data value for transfer.

3.13 static conformance: A statement of the requirement for support by an implementation of a valid set of features from among the defined features.

3.14 trailing 0 bit: A 0 in the last position of a bitstring value.

NOTE – The 0 in a bitstring value consisting of a single 0 bit is a trailing 0 bit. Its removal produces an empty bitstring.

4 Abbreviations

For the purposes of this Recommendation | International Standard, the following abbreviations apply:

ASN.1	Abstract Syntax Notation One
BER	Basic Encoding Rules of ASN.1
CER	Canonical Encoding Rules of ASN.1
DER	Distinguished Encoding Rules of ASN.1
ULA	Upper Layer Architecture

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: ISO_IEC 8825-1_2021

UTF8 Universal Transformation Function 8-bit (see ISO/IEC 10646, Annex D)

5 Notation

This Recommendation | International Standard references the notation defined by Rec. ITU-T X.680 | ISO/IEC 8824-1.

6 Convention

6.1 This Recommendation | International Standard specifies the value of each octet in an encoding by use of the terms "most significant bit" and "least significant bit".

NOTE – Lower layer specifications use the same notation to define the order of bit transmission on a serial line, or the assignment of bits to parallel channels.

6.2 For the purposes of this Recommendation | International Standard only, the bits of an octet are numbered from 8 to 1, where bit 8 is the "most significant bit", and bit 1 is the "least significant bit".

6.3 For the purpose of this Recommendation | International Standard, two octet strings can be compared. One octet string is equal to another if they are of the same length and are the same at each octet position. An octet string, S_1, is greater than another, S_2, if and only if either:

a) S_1 and S_2 have identical octets in every position up to and including the final octet in S_2, but S_1 is longer; or

b) S_1 and S_2 have different octets in one or more positions, and in the first such position, the octet in S_1 is greater than that in S_2, considering the octets as unsigned binary numbers whose bit n has weight 2^{n-1}.

7 Conformance

7.1 Dynamic conformance is specified by clauses 8 to 12 inclusive.

7.2 Static conformance is specified by those standards which specify the application of one or more of these encoding rules.

7.3 Alternative encodings are permitted by the basic encoding rules as a sender's option. Receivers who claim conformance to the basic encoding rules shall support all alternatives.

NOTE – Examples of such alternative encodings appear in 8.1.3.2 b) and Table 3.

7.4 No alternative encodings are permitted by the Canonical Encoding Rules or Distinguished Encoding Rules.

8 Basic encoding rules

8.1 General rules for encoding

8.1.1 Structure of an encoding

8.1.1.1 The encoding of a data value shall consist of four components which shall appear in the following order:

a) identifier octets (see 8.1.2);

b) length octets (see 8.1.3);

c) contents octets (see 8.1.4);

d) end-of-contents octets (see 8.1.5).

8.1.1.2 The end-of-contents octets shall not be present unless the value of the length octets requires them to be present (see 8.1.3).

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub

Full document details: ISO_IEC 8825-1_2021

8.1.1.3 Figure 1 illustrates the structure of an encoding (primitive or constructed). Figure 2 illustrates an alternative constructed encoding.

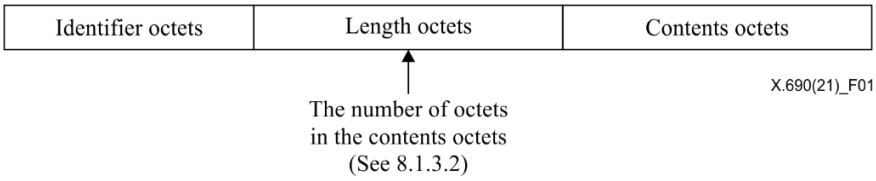

Figure 1 – Structure of an encoding

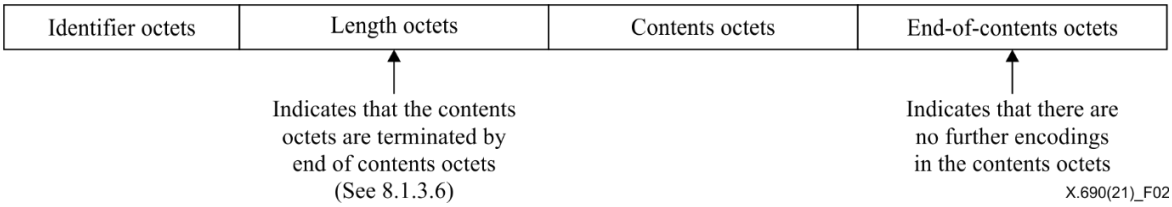

Figure 2 – An alternative constructed encoding

8.1.1.4 Encodings specified in this Recommendation | International Standard are not affected by either the ASN.1 subtype notation or the ASN.1 type extensibility notation.

NOTE – This means that all constraint notation is ignored when determining encodings, and all extensibility markers in **CHOICE**, **SEQUENCE** and **SET** are ignored, with the extensions treated as if they were in the extension root of the type.

8.1.1.5 There are no encoding instructions (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 3.8.27) defined for the encoding rules specified in this Recommendation | International Standard.

8.1.2 Identifier octets

8.1.2.1 The identifier octets shall encode the ASN.1 tag (class and number) of the type of the data value.

8.1.2.2 For tags with a number ranging from zero to 30 (inclusive), the identifier octets shall comprise a single octet encoded as follows:

a) bits 8 and 7 shall be encoded to represent the class of the tag as specified in Table 1;

b) bit 6 shall be a zero or a one according to the rules of 8.1.2.5;

c) bits 5 to 1 shall encode the number of the tag as a binary integer with bit 5 as the most significant bit.

Table 1 – Encoding of class of tag

Class	Bit 8	Bit 7
Universal	0	0
Application	0	1
Context-specific	1	0
Private	1	1

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: ISO_IEC 8825-1_2021