INTERNATIONAL STANDARD

ISO/IEC 8825-4

Fourth edition
2021-06

Information technology — ASN.1 encoding rules —

Part 4: XML Encoding Rules (XER)

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

Partie 4: Règles de codage XML (XER)

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Reference number
ISO/IEC 8825-4:2021(E)

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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)

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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.693 (02/2021).

This fourth edition cancels and replaces the third edition (ISO/IEC 8825-4:2015), which has been technically revised. It also incorporates ISO/IEC 8825-4:2015/Cor 1:2018.

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

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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 together describe Abstract Syntax Notation One (ASN.1), a notation for the definition of messages to be exchanged between peer applications.

This Recommendation | International Standard defines encoding rules that may be applied to values of ASN.1 types defined using the notation specified in Rec. ITU-T X.680 | ISO/IEC 8824-1 and Rec. ITU-T X.681 | ISO/IEC 8824-2. 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 is more than one set of encoding rules that can be applied to values of ASN.1 types. This Recommendation | International Standard defines three sets of encoding rules that use the Extensible Markup Language (XML). These encoding rules all produce an XML document compliant to W3C XML 1.0. The first set is called the Basic XML Encoding Rules (BASIC-XER). The second set is called the Canonical XML Encoding Rules (CANONICAL-XER, or CXER) because there is only one way of encoding an ASN.1 value using these encoding rules. (Canonical encoding rules are generally used for applications using security-related features such as digital signatures.) The third set is called the extended XML Encoding Rules (EXTENDED-XER). The extended XML Encoding Rules allow additional encoders options, and take account of encoding instructions that specify variations of the BASIC-XER encodings in order to support specific styles of XML documents (see below). The extended XML Encoding Rules are not canonical, and there is no canonical form for these rules defined in this Recommendation | International Standard.

There are many aspects of an XML representation of data (such as the use of XML attributes instead of child elements, or the use of white-space delimited lists) whose use is a matter of style and XML designer choice. If a type defined in an ASN.1 specification is encoded by BASIC-XER or by CXER, then there is a single fixed style used for the XML representation, with no user control of stylistic features. This Recommendation | International Standard specifies the syntax and semantics of XER encoding instructions which specify the stylistic features of the XML in an EXTENDED-XER encoding. XER encoding instructions can also be used to determine the possible insertion of XML processing instructions in an EXTENDED-XER encoding. XER encoding instructions are ignored by BASIC-XER and by CXER, but are used by EXTENDED-XER.

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NOTE – "Stylistic features", such as use of attributes or white-space delimited lists, can also affect the size of an encoding and the ease with which it can be processed, so use of such features is not just a matter of style. Where such issues are important, EXTENDED-XER with encoding instructions may be preferred over BASIC-XER or CXER.

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Clause 8 specifies the BASIC-XER encoding of ASN.1 types.

Clause 9 specifies the CXER encoding of ASN.1 types.

Clause 10 specifies the EXTENDED-XER encoding of ASN.1 types, referencing later clauses which define the XER encoding instructions.

Clauses 11 to 14 list and categorize the XER encoding instructions and specify the syntax for their assignment to an ASN.1 type or component using either an XER type prefix (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 31.3) or an XER encoding control section (see Rec. ITU-T X.680 | ISO/IEC 8824-1, clause 54).

Clause 15 defines the order of precedence if XER encoding instructions are present in both an XER type prefix and in an XER encoding control section.

Clause 16 specifies the XER encoding instruction support for XML namespaces when using EXTENDED-XER.

Clause 17 specifies EXTENDED-XER encodings.

Clauses 18 to 39 specify:

a) the syntax of each XER encoding instruction used in a type prefix or an XER encoding control section;

b) restrictions on the XER encoding instructions that can be associated with a particular ASN.1 type (resulting from inheritance and multiple assignments);

c) modifications to the XER encoding rules that are required in an EXTENDED-XER encoding when an XER encoding instruction is applied.

Annex A is informative and contains examples of BASIC-XER and CXER encodings.

Annex B is informative and contains a description of the partial XML content that is produced when constructions such as sequence and sequence-of have their surrounding tags removed, together with restrictions on EXTENDED-XER specifications that enable easy determination of the ASN.1 component that an XML element is associated with.

Annex C is informative and contains examples of XER encoding instructions and of the corresponding EXTENDED-XER encodings.

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INTERNATIONAL STANDARD
ITU-T RECOMMENDATION

Information technology – ASN.1 encoding rules: XML Encoding Rules (XER)

1 Scope

This Recommendation | International Standard specifies a set of basic XML Encoding Rules (BASIC-XER) that may be used to derive a transfer syntax for values of types defined in Rec. ITU-T X.680 | ISO/IEC 8824-1 and Rec. ITU-T X.681 | ISO/IEC 8824-2. This Recommendation | International Standard also specifies a set of Canonical XML Encoding Rules (CXER) which provide constraints on the basic XML Encoding Rules and produce a unique encoding for any given ASN.1 value. This Recommendation | International Standard further specifies a set of extended XML Encoding Rules (EXTENDED-XER) which adds further encoders options, and also allows the ASN.1 specifier to vary the encoding that would be produced by BASIC-XER. It is implicit in the specification of these encoding rules that they are also used for decoding.

The encoding rules specified in this Recommendation | International Standard:

- are used at the time of communication;
- are intended for use in circumstances where displaying of values and/or processing them using commonly available XML tools (such as browsers) is the major concern in the choice of encoding rules;
- allow the extension of an abstract syntax by addition of extra values for all forms of extensibility described in Rec. ITU-T X.680 | ISO/IEC 8824-1.

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This Recommendation | International Standard also specifies the syntax and semantics of XER encoding instructions, and the rules for their assignment and combination. XER encoding instructions can be used to control the EXTENDED-XER encoding for specific ASN.1 types.

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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 and the Unicode standard version 3.2.0:2002. It cannot be applied using later versions of these two standards.

2.1 Identical Recommendations | International Standards

- 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*.
- Recommendation ITU-T X.690 (2021) | ISO/IEC 8825-1:2021, *Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)*.

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– Recommendation ITU-T X.691 (2021) | ISO/IEC 8825-2:2021, *Information technology – ASN.1 encoding rules: Specification of Packed Encoding Rules (PER).*

– Recommendation ITU-T X.692 (2021) | ISO/IEC 8825-3:2021, *Information technology – ASN.1 encoding rules: Specification of Encoding Control Notation (ECN).*

– Recommendation ITU-T X.891 (2005) | ISO/IEC 24824-1:2007, *Information technology – Generic applications of ASN.1: Fast infoset*.

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

– IETF RFC 2045 (1996), *Multipurpose Internet Mail Extensions (MIME) Part One: Format of Internet Message Bodies.*

– IETF RFC 2141 (1997), *URN Syntax.*

– IETF RFC 2396 (1998), *Uniform Resource Identifiers (URI): Generic Syntax.*

– IETF RFC 3061 (2001), *A URN Namespace of Object Identifiers.*

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

– The Unicode Standard, Version 3.2.0, The Unicode Consortium. (Reading, MA, Addison-Wesley)

NOTE 1 – The graphics characters (and their encodings) defined by the above reference are identical to those defined by ISO/IEC 10646, but the above reference is included because it also specifies the names of control characters.

– W3C XML 1.0:2008, *Extensible Markup Language (XML) 1.0 (Fifth Edition), W3C Recommendation, Copyright ©2008 W3C® (MIT, ERCIM, Keio),* https://www.w3.org/TR/2008/REC-xml-20081126/ .

– W3C XML Namespaces:1999, *Namespaces in XML, W3C Recommendation, Copyright © 1999 W3C (MIT, INRIA, Keio), http://www.w3.org/TR/1999/REC-xml-names-19990114.*

NOTE – The reference to a document within this Recommendation | International Standard does not give it, as a stand-alone document, the status of a Recommendation or International Standard.

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3 Definitions

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

3.1 ASN.1 Basic Encoding Rules (BER)

This Recommendation | International Standard makes use of the following terms defined in Rec. ITU-T X.690 | ISO/IEC 8825-1:

a) data value;

b) dynamic conformance;

c) encoding (of a data value);

d) receiver;

e) sender;

f) static conformance.

3.2 Additional definitions

For the purposes of this Recommendation | International Standard, the following definitions apply.

3.2.1 ASN.1 schema: The definition of the content and structure of data using an ASN.1 type definition.

NOTE – This enables encoding rules to produce binary encodings of the values of an ASN.1 type, or encodings using XML.

3.2.2 associated empty-element tag: The XML empty-element tag that can replace an associated preceding tag and an associated following tag, when present.

NOTE – Some encoding instructions remove the associated tags of an "XMLValue".

3.2.3 associated encoding instructions (for a type): A set of XER encoding instructions associated with a type.

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3.2.4 associated following tag: The XML end-tag following the "XMLValue" of a type in the absence of encoding instructions that remove the associated tags.

3.2.5 associated preceding tag: The XML start-tag preceding the "XMLValue" of a type in the absence of encoding instructions that remove the associated tags.

3.2.6 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.

3.2.7 canonical valid XML document (for an ASN.1 schema): An XML document which is well-formed (see W3C XML 1.0) and whose content conforms to the CXER specification for the encoding of an ASN.1 type specified by an ASN.1 schema.

3.2.8 character-encodable type: An ASN.1 type to which an **ATTRIBUTE** encoding instruction can be applied (see 20.2.1).

3.2.9 control namespace: A namespace that is used to identify attributes that perform functions or carry values that control an EXTENDED-XER encoding.

NOTE 1 – An example would be a type identification attribute. The control namespace defaults to the ASN.1 namespace specified in 16.9, but can be changed by the **GLOBAL-DEFAULTS** encoding instruction.

NOTE 2 – The control namespace may also contain names for attributes that may be present, but which are ignored by EXTENDED-XER decoders (see 10.2.10). An example of such an attribute name could be **schemaLocation**.

3.2.10 enclosed (ASN.1) type: An ASN.1 type whose "XMLValue" in a BASIC-XER encoding is enclosed directly within the "XMLValue" of an ASN.1 type (the enclosing type).

NOTE – All types in a BASIC-XER or EXTENDED-XER encoding are enclosed types unless they are used as the root type (see 10.3.1 b) in an encoding.

3.2.11 enclosing element (of an ASN.1 type): An "ExtendedXMLTypedValue", "ExtendedXMLChoiceValue", "ExtendedXMLNamedValue" or "ExtendedXMLDelimitedItem" that has as its "ExtendedXMLValue" the "ExtendedXMLValue" encoding of the type (see 17.1, 17.5, 17.6 and 17.7).

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3.2.12 enclosing type (of an ASN.1 type): An ASN.1 type whose "XMLValue" in a BASIC-XER encoding directly encloses the "XMLValue" of an ASN.1 type (an enclosed type).

NOTE – The enclosing type can be a sequence type, a set type, a choice type, a sequence-of type, a set-of type, an open type, or an octetstring or bitstring type (with a **CONTAINING** and without an **ENCODED BY**).

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3.2.13 final encoding instructions (for a type): The set of XER encoding instructions associated with a type as a result of the complete ASN.1 specification, and which are applied in producing encodings of that type.

3.2.14 inherited encoding instructions: XER encoding instructions that are associated with the type identified by a type reference.

3.2.15 namespace-qualified name: A name in an XML document that has an XML namespace prefix or is an XML element name in the scope of an XML default namespace declaration.

NOTE – XML default namespace declarations affect only XML element names, not the names of attributes. A namespace prefix can be applied to either.

3.2.16 nil identification attribute: An XML attribute that can appear on any element to identify whether the content has a **nil** value (see clause 33).

3.2.17 partial XML element content: XML child elements defined by an ASN.1 type which is **UNTAGGED**, and which provides part of the XML element content generated by the enclosing type.

NOTE – If the enclosing type is itself **UNTAGGED**, then that enclosing type may also be generating only partial XML element content.

3.2.18 prefixed encoding instructions: XER encoding instructions that are assigned using a type prefix.

NOTE – Prefixed encoding instructions can delete, replace, or add to the associated encoding instructions of a type.

3.2.19 qualifying information: Information supplied as part of the specification of a target for the assignment of an encoding instruction that identifies specific values of the target type.

3.2.20 targeted encoding instructions: XER encoding instructions that are assigned using a target list in an XER encoding control section.

NOTE – Targeted encoding instructions can delete, replace, or add to the associated encoding instructions of a type.

3.2.21 type identification attribute: An XML attribute that can appear on any element to identify the type of that element (see clause 37).

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3.2.22 uniform resource identifier (URI): A globally unambiguous identifier, assigned according to any one of a number of URI schemes, used to provide identification of namespaces in EXTENDED-XER encodings.

NOTE – The URI scheme used by default for ASN.1 enables an ASN.1 object identifier value to be used to identify namespaces (see 16.9 and 29.1.5).

3.2.23 valid XML document (for an ASN.1 schema): An XML document which is well-formed (see W3C XML 1.0) and whose content conforms to the BASIC-XER, CXER or EXTENDED-XER specification for the encoding of an ASN.1 type specified by an ASN.1 schema, possibly including XER encoding instructions.

3.2.24 XER encoding instructions: Notation used to change the EXTENDED-XER encoding of a type (or of a component of a type).

NOTE – XER encoding instructions are included in either an XER type prefix (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 31.3) or an XER encoding control section (see Rec. ITU-T X.680 | ISO/IEC 8824-1, clause 54).

3.2.25 XML attribute: Part of an EXTENDED-XER encoding consisting of an "XMLValue" enclosed in quotation marks or apostrophes, preceded by an (attribute) name and an equals sign.

3.2.26 XML element: Part of an XML document specified in W3C XML 1.0.

NOTE – An XML element is either an empty-element tag or starts with a start-tag and ends with an end-tag. Both the start-tag and the empty-element tag can contain attribute encodings.

3.2.27 XML element name: The lexical item following a "<" or "</" lexical item in the associated tags.

3.2.28 XML document: A sequence of characters which conforms to the W3C XML 1.0 definition of document.

3.2.29 XML processing instruction: Part of an XML document which carries information concerning the processing of some or all of that document (see W3C XML 1.0).

NOTE – The processing instruction identifies the type of processing for which it is applicable, and is ignored in other processing. It could be used to identify a style-sheet that is to be applied if the document is presented for human viewing.

3.2.30 XML prolog: The initial part of an XML document (which does not carry information about the value of the ASN.1 type that has been encoded).

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4 Abbreviations

ISO/IEC 8825-4:2021
https://standards.iteh.ai/catalog/standards/sist/8539a83c-f031-49dc-aa7a-9b529d956e7b/iso-iec-8825-4-2021

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

ASN.1	Abstract Syntax Notation One
CXER	Canonical XML Encoding Rules
PDU	Protocol Data Unit
UCS	Universal Multiple-Octet Coded Character Set
URI	Uniform Resource Identifier
UTC	Coordinated Universal Time
UTF-8	UCS Transformation Format, 8-bit form
XER	XML Encoding Rules
XML	Extensible Markup Language

5 Encodings specified by this Recommendation | International Standard

5.1 This Recommendation | International Standard specifies three sets of encoding rules:

– Basic XML Encoding Rules (BASIC-XER);

– Canonical XML Encoding Rules (CXER);

– Extended XML Encoding Rules (EXTENDED-XER).

5.2 The basic set of encoding rules specified in this Recommendation | International Standard is BASIC-XER, which does not in general produce a canonical encoding, and which does not provide any user control over the style of XML which is produced.

5.3 A second set of encoding rules specified in this Recommendation | International Standard is CXER, which produces encodings that are canonical. This is defined as a restriction of implementation-dependent choices in the BASIC-XER encoding.

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NOTE 1 – Any implementation conforming to CXER for encoding is conformant to BASIC-XER for encoding. Any implementation conforming to BASIC-XER for decoding is conformant to CXER for decoding. Thus, encodings made according to CXER are encodings that are permitted by BASIC-XER.

NOTE 2 – CXER produces encodings that have applications when authenticators need to be applied to abstract values.

5.4 The third set of encoding rules specified in this Recommendation | International Standard is EXTENDED-XER. This is defined as variations of the BASIC-XER encodings specified by XER encoding instructions (see 6) associated with an ASN.1 type. In the absence of XER encoding instructions, an EXTENDED-XER encoding differs from a BASIC-XER encoding only because it provides more encoders options.

5.5 If a type encoded with CXER contains **`EMBEDDED PDV`**, **`EXTERNAL`** or **`CHARACTER STRING`** types, then the outer encoding ceases to be canonical unless the encoding used for all the **`EMBEDDED PDV`**, **`EXTERNAL`** and **`CHARACTER STRING`** types is canonical.

6 Encoding instructions specified by this Recommendation | International Standard

6.1 This Recommendation | International Standard specifies the syntax and semantics of XER encoding instructions (see clauses 11 to 39). XER encoding instructions only affect EXTENDED-XER encodings.

6.2 ASN.1 forms a basic XML schema notation. The ASN.1 schema is used to define the content and structure of data using ASN.1 and the BASIC-XER (and CXER) encoding rules. It can be used without XER encoding instructions.

6.3 XER encoding instructions provide wider flexibility in the XML documents that can be specified.

6.4 XER encoding instructions are assigned to ASN.1 type definitions or to type references using either or both of XER type prefixes (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 31.3) and an XER encoding control section (see Rec. ITU-T X.680 | ISO/IEC 8824-1, clause 54). If encoding instructions are associated with a type definition, they are carried with the ASN.1 type (through its type reference) into other type definitions and other ASN.1 modules. When EXTENDED-XER encodes a type that has XER encoding instructions associated with some or all of its parts, those final encoding instructions are applied and modify the EXTENDED-XER encodings that are produced.

NOTE – The final encoding instructions are also used when performing validation and/or decoding of an EXTENDED-XER encoding.

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7 Conformance

7.1 Dynamic conformance for the basic XML Encoding Rules is specified by clause 8, and dynamic conformance for the Canonical XML Encoding Rules is specified by clause 9, and dynamic conformance for the extended XML Encoding Rules is specified by clause 10.

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 XML Encoding Rules and by the extended XML Encoding Rules as an encoder's option. Decoders that claim conformance to BASIC-XER shall support all BASIC-XER alternatives. Decoders that claim conformance to EXTENDED-XER shall support all EXTENDED-XER encoding alternatives.

NOTE – This clause applies whether or not there are any final encoding instructions.

7.4 No alternative encodings are permitted by the Canonical XML Encoding Rules for the encoding of an ASN.1 value.

8 Basic XML encoding rules

8.1 Production of a complete BASIC-XER encoding

8.1.1 A conforming BASIC-XER encoding is a valid XML document which shall consist of:

a) an XML prolog (which may be empty) as specified in 8.2;

b) an XML document element which is the complete encoding of a value of a single ASN.1 type as specified in 8.3.

8.1.2 The specification in 8.2 to 8.6 completely defines the BASIC-XER encoding.

NOTE – Other constructs of W3C XML 1.0, such as XML processing instructions, are not allowed by those subclauses, and are never produced by a conforming BASIC-XER encoder.

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