BS ISO 8601-2:2019+A1:2025

BSI Standards Publication

Date and time — Representations for information interchange

Part 2: Extensions

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National foreword

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Part 2: Extensions

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 ISO documents 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).

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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.

This document was prepared by Technical Committee ISO/TC 154, *Processes, data elements and documents in commerce, industry and administration*.

This first edition of ISO 8601-2, together with ISO 8601-1, cancels and replaces ISO 8601:2004, which has been technically revised.

The main changes compared to ISO 8601:2004 are as follows:

— addition of standard representations for concepts not previously supported, such as negative values, qualification, sets, seasons, extended time intervals, selections, grouped units, repeating rules and profiles.

A list of all parts in the ISO 8601 series can be found on the ISO website.

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.

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Introduction

The purpose of this document is to provide a set of date and time format representations for information interchange beyond those supported by ISO 8601-1.

There are various concepts and representations that many applications find useful not supported by ISO 8601-1, including:

— negative values for time scale components;

— qualification of expressions and time scale components;

— set representation of date and time expressions;

— seasons;

— time intervals with open or unknown starts or ends;

— expression of movable days through date and time selection;

— date and time expressions without digit length limits; and

— profiles for specifying feature support amongst ISO 8601 (all parts) features.

Such concepts are often represented according to various ad-hoc conventions; this document aims to provide a standard syntax for their representation.

The extended representations allow unambiguous interpretation, enforce the confidence of interoperability and minimize the risk of misinterpretations and their consequences.

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Date and time — Representations for information interchange —

Part 2: Extensions

1 Scope

This document specifies additional representations of dates of the Gregorian calendar and times based on the 24-hour clock that extend the basic rules and composite elements of those defined in ISO 8601-1. These representations are specified as character strings for use in information interchange. It is also applicable for representing times and time shifts based on Coordinated Universal Time (UTC).

These extensions include:

— uncertain or approximate dates, or dates with portions unspecified;

— extended time intervals;

— divisions of a year;

— sets and choices of calendar dates;

— grouped time scale units;

— repeat rules for recurring time intervals; and

— date and time arithmetic.

This document excludes the representation of date elements from non-Gregorian calendars, or times not from the 24-hour clock. This document does not address character encoding of representations specified in this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 8601-1:2019, *Date and time — Representation for information interchange — Part 1: Basic rules*

3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the terms and definitions given in ISO 8601-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

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3.1 Terms and definitions

3.1.1 Basic concepts

3.1.1.1
approximate date
calendar date which is an estimate whose value is asserted to be possibly correct

Note 1 to entry: The degree of confidence in approximation depends on the application.

3.1.1.2
uncertain date
calendar date whose source is considered *dubious* (3.1.1.4)

3.1.1.3
date with unspecified part
calendar date of which a part is unstated

Note 1 to entry: The unstated part can be year, year and month, month, month and day, or year and day. It is unstated because it has not (yet) been assigned (it can be assigned in the future), or because it is classified or unknown, or for any other reason.

3.1.1.4
dubious
not to be relied upon

3.1.1.5
qualification symbol
symbol that indicates certain qualification to a value it applies to

EXAMPLE The symbol [?] indicates that the value it applies to is uncertain.

3.1.1.6
movable day
repeatedly occurring day in a calendar that is represented by criteria set by one or more *selection rules* (3.1.2.6), but does not always resolve to a fixed calendar day in every repeating cycle

EXAMPLE 1 Thanksgiving Day in the U.S. and Canada are considered movable days, set to the fourth Thursday in November and the second Monday in October, respectively.

EXAMPLE 2 First Day of Summer (*sumardagurinn fyrsti*) in Iceland is considered a movable day, set to the first Thursday after April 18th.

EXAMPLE 3 Father's Day is celebrated on the third Sunday in June in North America and is considered a movable day.

Note 1 to entry: The selection of this term pays homage to the phrase "movable feast" used in some calendars to indicate the rule-based determination of annual events.

3.1.1.7
negative duration
duration in the reverse direction to the proceeding time scale

3.1.2 Feature description

3.1.2.1
feature
single function or group of functions

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3.1.2.2
conformity level
value assigned to a subset of *features* (3.1.2.1) within a *profile* (3.1.2.3)

Note 1 to entry: A profile may refer to these conformity levels to facilitate the specification of conformance to the profile.

3.1.2.3
profile
subset of *features* (3.1.2.1) described in a standard or a set of standards

Note 1 to entry: A community may develop a profile to describe how to carry out functions or apply features specified in a standard or family of standards in a manner relevant to that community.

Note 2 to entry: A profile often describes what features are to be supported and how to apply those features. In cases where multiple methods are allowed for a required feature, a profile may select a single method. In cases where a particular function allows different interpretations, a profile may select a single interpretation or provide clarification. A profile may list out features that need not be supported. It may specify several *conformity levels* (3.1.2.2).

Note 3 to entry: The term "profile" is used in this document with the specific definition (including the notes) given here, despite its various meanings in other contexts.

3.1.2.4
ISO 8601 profile
profile (3.1.2.3) whose base standard is the ISO 8601 series

3.1.2.5
repeat rule
set of *eligible time intervals* (3.1.2.8) and *selection rules* (3.1.2.6) that allows computation of a set of *matching instants* (3.1.2.9)

3.1.2.6
selection rule
rule specifying restrictions on the value of a time scale component

3.1.2.7
repeat cycle
set of repeating instants, calculated by a specified start instant and specified duration gap between the repeating instants

3.1.2.8
eligible time interval
time interval eligible for matching using *selection rules* (3.1.2.6)

3.1.2.9
matching instants
set of instants, computed by a *repeat rule* (3.1.2.5), that belongs within *eligible time intervals* (3.1.2.8) and fulfils criteria set by specified *selection rules* (3.1.2.6)

3.1.2.10
date time formula
expression that specifies modification of a date and time expression with a duration

3.1.2.11
durational unit
time scale component that composes the duration date and time representation

3.1.2.12
grouped time scale unit
time scale unit composed of a duration expressed by one or more *durational units* (3.1.2.11)

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3.1.2.13
equation of time
difference between mean solar time and apparent solar time, which varies with time within a calendar year

Note 1 to entry: A clock is a type of device that measures mean solar time; a sundial is a type of device that measures apparent solar time.

A1 **3.1.2.14**
canonical form
date and time expression where all its time scale components are *normalised* (3.1.2.15)

Note 1 to entry: The canonical form of a date and time expression implies it contains minimal underflow and no overflow.

3.1.2.15
normalise
process to ensure time scale components have values in their defined inclusive ranges

3.1.2.16
normalised duration
duration whose time scale components have values that are *normalised* (3.1.2.15)

Note 1 to entry: This also applies to negative durations.

3.1.2.17
overflow
state of a time scale component with a positive value when paired with a higher-order time scale component it is unequivocally convertible with, that holds a value representing a duration exceeding one unit of the higher-order time scale component

Note 1 to entry: A time scale component can only be in overflow when considered against a higher-order time scale component it is unequivocally convertible with.

Note 2 to entry: The state of overflow is considered resolved if the time scale component has a value representing a duration less than one unit of the higher-order time scale component.

EXAMPLE 1 A calendar day time scale component representing 10 calendar days is considered in overflow when the higher-order time scale component considered is a calendar week, as the calendar day and calendar week are an unequivocally convertible time scale component pair.

EXAMPLE 2 A calendar day time scale component representing 35 calendar days is not considered in overflow when the higher-order time scale component considered is a calendar month, as the calendar day and calendar month are not an unequivocally convertible time scale component pair.

3.1.2.18
underflow
state of a time scale component with a negative value when paired with a higher-order time scale component it is unequivocally convertible with, where the result of combining the duration represented by the higher-order time scale component and the duration represented by the lower-order time scale component is larger than or equal to zero

Note 1 to entry: A time scale component can only be in underflow when considered against a higher-order time scale component it is unequivocally convertible with.

Note 2 to entry: In resolving time scale component underflows, the negative value of the lower-order time scale component can be expressed in a semantically equivalent form using a combination of the lower-order and higher-order time scale components with values for both larger than or equal to zero.

EXAMPLE 1 A calendar month time scale component representing −8 calendar months is considered in underflow when the higher-order time scale component considered is a calendar year with a value of 1 (which is equivalent to 12 calendar months), as the calendar month and calendar year are an unequivocally convertible time scale component pair.

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EXAMPLE 2 A calendar day time scale component representing −60 calendar days is not considered in underflow when the higher-order time scale component considered is a calendar month, as the calendar day and calendar month are not an unequivocally convertible time scale component pair.

EXAMPLE 3 A calendar day time scale component representing −10 calendar days is considered in underflow when the higher-order time scale component considered is a calendar week with a value of 2, but it is not considered in underflow when the calendar week has a value of 1, since a calendar week is equivalent to 7 calendar days, which when combined with −10 calendar days results in a duration less than zero. ⟨A1⟩

3.1.3 Seasons

3.1.3.1
season
time interval resulting from the common division of a calendar year into four time intervals, *spring* (3.1.3.2), *summer* (3.1.3.3), *autumn* (3.1.3.4) or *winter* (3.1.3.5)

Note 1 to entry: A single calendar date may represent different seasons depending on local customs or location, such as the difference between the northern or southern hemispheres.

3.1.3.2
spring
season (3.1.3.1) following *winter* (3.1.3.5) and preceding *summer* (3.1.3.3)

3.1.3.3
summer
season (3.1.3.1) following *spring* (3.1.3.2) and preceding *autumn* (3.1.3.4)

3.1.3.4
autumn
season (3.1.3.1) following *summer* (3.1.3.3) and preceding *winter* (3.1.3.5)

3.1.3.5
winter
season (3.1.3.1) following *autumn* (3.1.3.4) and preceding *spring* (3.1.3.2)

3.2 Symbols and abbreviated terms

3.2.1 General

Representations and expressions specified in this document make use of the symbols given in ISO 8601-1 and the following.

3.2.2 Time scale component symbols

c(feat)	the left side of a representation statement where "c" is a time scale component (e.g. "year") and "feat" is a feature, for example "q" or "m" (see below)
yearE	time scale component calendar year in explicit form, specified in ISO 8601-1:2019, 4.3.2 b)
monthE	time scale component calendar month in explicit form, specified in ISO 8601-1:2019, 4.3.3 b)
weekE	time scale component calendar week of year in explicit form, specified in ISO 8601-1:2019, 4.3.4 b)
dayE	time scale component calendar day of month in explicit form, specified in ISO 8601-1:2019, 4.3.5 b)
daykE	time scale component calendar day of week in explicit form, specified in 4.3.3

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dayoE	time scale component calendar day of year in explicit form, specified in 4.3.4
hourE	time scale component hour in explicit form, specified in ISO 8601-1:2019, 4.3.8 b)
minE	time scale component minute in explicit form, specified in ISO 8601-1:2019, 4.3.9 b)
secE	time scale component second in explicit form, specified in ISO 8601-1:2019, 4.3.10 b)
decE	time scale component decade (defined in ISO 8601-1:2019, 3.1.2.22) in explicit form, specified in 4.3.5
centE	time scale component century (defined in ISO 8601-1:2019, 3.1.2.23) in explicit form, specified in 4.3.6
season	the values 21 to 24 as specified in 4.8.1
ydivision	the values 25 to 41 as specified in 4.8.1
seasonE	the values 21 to 41 as specified in 4.8.1
expr *i*	any date and time expression, where i is empty or a positive integer
intexpr	a date and time expression accepted by the time interval representation as start or end as determined in ISO 8601-1:2019, 5.4.3.

3.2.3 Composite component symbols

dateI	date representation in implicit form, specified in ISO 8601-1:2019, 3.2.3 as date and dateX
timeI	time of day representation in implicit form, specified in ISO 8601-1:2019, 3.2.3 as time and timeX
timeE	time of day representation in explicit form
dtE	date and time representation in explicit form
dsE	date with shift representation in explicit form
dtsE	date and time with shift representation in explicit form
tiseE	time interval representation with a start and end in explicit form
tisdE	time interval representation with a start in explicit form and duration
tiedE	time interval representation with a duration and end in explicit form
positiveDuration	representation of [duration] specified in ISO 8601-1:2019, 5.4.2 that contains only time scale components that have positive values
timeUnits	time scale components for time of day representation
groupUnit	grouped time scale unit representation
group	grouped time scale unit representation with value
groupDateTime	date time representation that incorporates grouped time scale units
timeIntervalE	collective representation of tiseE, tisdE, and tiedE

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3.2.4 Symbols used to represent time scale component features

q qualified form for time scale components, as specified in 4.5

p prefixed year, only used in accordance with requirements specified in 4.7.2

e exponential form for time scale components, as specified in 4.7.3

s significant digits form for time scale components, as specified in 4.4.3

m minus form to allow time scale components to accept negative integer values, as specified in 4.4.1

3.2.5 Symbols used in date and time representations

! symbol indicating that the token following this symbol is optional (may be omitted)

Q placeholder for a qualification modifier which applies to the time scale component value

AA the grouping digit pair, representing a two-digit integer that is 21 or greater

I a positive integer

negi a positive or negative integer; equivalent to [!]["-"][i]

3.2.6 Designator symbols used in date and time expressions

"-" a minus sign represented by the character "-" to indicate a negative value

"K" the calendar day of week designator, represented by the character "K", preceding a data element which represents the ordinal number of a calendar day within a calendar week

"J" the decade designator, represented by the character "J", preceding a data element which represents the decade number

"C" the century designator, represented by the character "C", preceding a data element which represents the century number

"O" the calendar day of year designator, represented by the character "O", preceding a data element which represents the ordinal number of a calendar day within a calendar year

"B" the suffix designator to represent years before year one (1), represented by the character "B", placed after the time scale components of calendar year, decade and century

"E" the exponent designator, represented by the character "E", preceding the component which represents the exponential part of a time scale component value

"S" the significant digit designator, represented by the character "S", preceding the component which represents the number of significant digits of the time scale component value

"G" the grouped time scale unit prefix designator, represented by the character "G", indicating that a grouping calculation applies to the subsequent time scale components until encountering the corresponding suffix designator

"U" the grouped time scale unit suffix designator, represented by the character "U", indicating that a grouping calculation applies to the preceding time scale components from the corresponding prefix designator

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"I" the instance designator, represented by the character "I", indicating that a specific instance is to be selected within the time scale component

"F" the frequency designator, represented by the character "F", preceding the component which represents the frequency part of a repeat rule

"L" the selection prefix designator, represented by the character "L", preceding the component which represents the selection part of a repeat rule until encountering the corresponding suffix designator

"N" the selection suffix designator, represented by the character "N", following the component which represents the selection part of a repeat rule from the corresponding prefix designator

"X" the unspecified digit, used within a date with unspecified part, represented by the character "X", indicating that the time scale component value of the specific digit it replaces is unspecified

"*" the unspecified digit modifier, represented by the character "*", indicating, when used with the unspecified digit as "X*", that the entire time scale component value it applies to is unspecified

"?" qualification modifier, represented by the character "?", indicating that the time scale component value it applies to is uncertain

"~" qualification modifier, represented by the character "~", indicating that the time scale component value it applies to is approximate

"%" qualification modifier, represented by the character "%", indicating that the time scale component value it applies to is both uncertain and approximate

"..*x* indicating "on or before" value *x* if applied as a prefix to a time scale component

x".." indicating "on or after" value *x* if applied as a suffix to a time scale component

x"..*y* indicating "between x and y" (inclusive) when applied between two time scale components

NOTE 1 The designator symbol "J" is assigned from its ordinal position being the tenth letter of the English alphabet.

NOTE 2 The designator symbols "G" and "U" are used to demarcate the "grouped time scale unit" time scale components as they are the initial letters of the words "group" and "unit".

3.2.7 Component symbols, representations and expressions

Throughout this document are statements of the form:

$$\langle \text{component symbol} \rangle = \langle \text{representation} \rangle$$

This means that the <component symbol> is assigned a representation <representation>, where the <representation> describes accepted symbols.

EXAMPLE The statement 'year(q) = [!][Q][YYYY]' means that the component symbol "year(q)" is represented as "[!][Q][YYYY]", year(q) is the symbol for "qualified form for year", and "[!][Q][YYYY]" means the string "YYYY" optionally preceded by a qualification character. Thus, for year 1985 and qualification character '?', the representation [!][Q][YYYY], would result in the expression '1985' or '?1985'.

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4 Extensions to time scale components and units

4.1 General

Units of time scales specified in ISO 8601-1 are extended according to rules specified in this clause.

Features described in this clause that apply to implicit forms (e.g., [dateI]) shall only be used together with the extended formats (where separators are placed between time scale components); these features shall not be used with the basic formats of the implicit forms.

4.2 Order of time scale units

This document refers to an "order" amongst time scale units, which is defined by the duration of a time scale unit relative to other time scale units. For example, since a single calendar month has a duration always greater than a single unit of calendar day, the former is considered a higher order time scale unit than the latter.

The relative order of commonly used time scale units is specified below, with the higher listed entry considered a higher order time scale unit than a lower listed entry:

— calendar century;

— calendar decade;

— calendar year;

— calendar month;

— calendar week;

— calendar day;

— clock hour;

— clock minute;

— clock second.

NOTE a higher order time scale does not necessarily mean its duration can be expressed as an integer multiple of a lower order time scale. For example, a calendar month can have 28, 29, 30 or 31 days and cannot always be expressed as an integer multiple of a calendar week (7 days).

4.3 Additional explicit forms

4.3.1 General

In ISO 8601-1, explicit forms of time scale components are used for the representation of duration only. This subclause extends usage of explicit forms for the representation of date and time.

4.3.2 Value prefixing

Prefixing of the value with one or more "0"s (the number zero) to the integer [i] is allowed in the explicit forms of time scale components.

EXAMPLE '1M', '01M' and '0001M' all describe the calendar month January.

4.3.3 Calendar day of week

The calendar day of week is represented below, as an extension to ISO 8601-1:2019, 4.3.6:

Explicit:

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[i]["K"]

EXAMPLE '1K' in explicit form expresses the week day Monday.

4.3.4 Calendar day of year

The calendar day of year is represented below, as an extension to ISO 8601-1:2019, 4.3.7:

Explicit:

[i]["O"]

EXAMPLE '350O' in explicit form expresses the ordinal day 350 of a year.

4.3.5 Decade

The decade is represented below as an extension to ISO 8601-1:2019, 4.3.11:

Explicit:

[i]["J"]

EXAMPLE 1 '196J' in explicit form expresses the decade of the 1960s, spanning the calendar years 1960 to 1969.

EXAMPLE 2 '0J' in explicit form expresses the decade spanning calendar years 0 to 9.

4.3.6 Century

The century is represented below as an extension to ISO 8601-1:2019, 4.3.12:

Explicit:

[i]["C"]

EXAMPLE 1 '16C' in explicit form expresses the century of the 1600s, spanning the calendar years 1600 to 1699.

EXAMPLE 2 '0C' in explicit form expresses the century spanning the calendar years 00 to 99.

4.4 Numerical extensions

4.4.1 Negative values

4.4.1.1 General

Certain time scale components are allowed to accept a negative integer as their value. The following symbol is used in representations that accept a positive or negative integer.

negi = [!]["-"][i]

In order to convert a time scale component to accept negative values, the following representation is used.

c(m) = [negi][c]

where

[c] is the time scale component representation that accepts non-negative values only;

[m] is a feature label extending the time scale component [c] to accept negative values.

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This representation only applies to time scale components that describe a time scale unit.

EXAMPLE If "c" is the time scale component [yearE] in explicit form (see ISO 8601-1:2019, 4.3.2, b)), c(m) means "calendar year accepting a negative value". The explicit year representation [i]["Y"] becomes [negi]["Y"] when [i] is replaced with [negi], and expands to [!]["-"][i]["Y"], which accepts the representations [i]["Y"] or ["-"][i]["Y"]. In expressions of this representation, the value of [i] or ["-"][i] represents a non-zero integer whose value identifies a calendar year.

4.4.1.2 Calendar year

In ISO 8601-1, a negative calendar year cannot be expressed for the years -0001 through -9999. This subclause removes that restriction.

The calendar year is represented as follows, where a) and b) extend ISO 8601-1:2019, 4.3.2, allowing negative values for years prior to year zero (0):

a) Implicit:

year(m) = [!]["-"][year]

EXAMPLE 1 '-1985' in implicit form expresses the calendar year -1985.

b) Explicit:

yearE(m) = [!]["-"][yearE]

EXAMPLE 2 '-2018Y' in explicit form expresses the calendar year -2018.

When a negative calendar year represents a date, the negative value is to represent the number of years prior to year zero (0) (year zero is expressed as '0000' in implicit form and '0Y' in explicit form).

EXAMPLE 3 The year immediately preceding year zero (0) is expressed as '-0001' in implicit form and '-1Y' in explicit form.

4.4.1.3 Calendar week of year

The calendar week of year is represented as follows extending ISO 8601-1:2019, 4.3.4:

Explicit:

weekE(m) = [!]["-"][weekE]

When a negative calendar week of year represents a date, the negative value expresses the number of weeks counting in reverse from the end of the calendar year, where the last week of the year is represented by the integer value '-1'.

EXAMPLE '-3W' expresses the third last week of the year.

4.4.1.4 Calendar day of month

The calendar day of month is represented as follows extending ISO 8601-1:2019, 4.3.5:

Explicit:

dayE(m) = [!]["-"][dayE]

When a negative calendar day of month represents a date, the negative value expresses the number of days counting in reverse from the end of the calendar month, where the last day of the month is represented by the integer value '-1'.

EXAMPLE '-5D' represents the fifth last day of the month.

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4.4.1.5 Calendar day of year

The calendar day of year is represented as follows extending 4.3.4:

Explicit:

dayoE(m) = [!]["-"][dayoE]

When a negative calendar day of year represents a date, the negative value expresses the number of days counting in reverse from the end of the calendar year, where the last day of the year is represented by the integer value '-1'.

EXAMPLE 1 '-7O' represents the seventh last day of the calendar year, which is always December 25th.

EXAMPLE 2 '-306O' represents February 29th for a leap year and February 28th otherwise.

4.4.1.6 Calendar year before year one (1)

The calendar year before year one (1) is represented as follows:

Explicit:

[yearE]["B"]

EXAMPLE 1 '1YB' the first year before year one (1), equivalent to the effect of '0Y'.

EXAMPLE 2 '12YB' the twelfth year before year one (1), equivalent to the effect of '-11Y'.

4.4.1.7 Calendar decade before year one (1)

The calendar decade before year one (1) extends the calendar decade's implicit form (specified in ISO 8601-1:2019, 4.3.11) and its explicit form (specified in 4.3.5) to accept negative values. It identifies a decade consisting of all ten years identified by the provided digits with an additional digit appended.

In implicit form, the calendar decade before year one (1) is specified by a three-digit negative integer. There is no digit limitation in explicit form.

The respective forms are represented as follows:

a) Implicit:

dec(m) = [!]["-"][dec]

EXAMPLE 1 '-019' in implicit form expresses the years -199 through -190.

b) Explicit:

decE(m) = [!]["-"][decE]

EXAMPLE 2 '-12J' in explicit form expresses the years -129 through -120.

EXAMPLE 3 The "negative zero decade" is identified by '-000' in implicit form ('-0J' in explicit form), which expresses year -9 through year zero (0).

NOTE Zero decade and negative zero decade are not the same decade. They overlap; both include year zero (0).

4.4.1.8 Calendar century before year one (1)

The calendar century before year one (1) extends the calendar century's implicit form (specified in ISO 8601-1:2019, 4.3.2) and its explicit form (specified in 4.3.6) to accept negative values. It identifies a century consisting of all 100 years identified by those digits with an additional two digits appended.

In implicit form, the calendar decade before year one (1) is specified by a two-digit negative integer. There is no digit limitation in explicit form.

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The respective forms are represented as follows:

a) Implicit:

cent(m) = [!]["-"][cent]

EXAMPLE 1 '-19' in implicit form expresses the years -1999 through -1900.

b) Explicit:

centE(m) = [!]["-"][centE]

EXAMPLE 2 '-12C' in explicit form expresses the years -1299 through -1200.

EXAMPLE 3 The "negative zero century" is identified by '-00' in implicit form ('-0C' in explicit form), which expresses year -99 through year zero (0).

NOTE Zero century and negative zero century are not the same century. They overlap; both include year zero (0).

4.4.1.9 Duration

A duration in the reverse direction, called a "negative duration" in this document, can be expressed using the following representation based on the [duration] representation specified in ISO 8601-1:2019, 5.5.2. In this case, all time scale components within the duration representation shall be positive.

duration(m) = [!]["-"][positiveDuration]

where [positiveDuration] is the representation of a positive duration.

EXAMPLE 1 '-P100D' in date represents the duration of 100 days in the reverse direction. The duration formula 'P365D - P100D' results in 'P265D'.

EXAMPLE 2 '-P1Y3D' in date represents the duration of one year and three days in the reverse direction. The duration formula 'P5Y6D - P1Y3D' results in 'P4Y3D'.

4.4.2 Exponential values

In some cases, the representation of a value scale is more important than the need for accuracy. The following representation is used for a value that accepts an exponential value. This mechanism originates from Library of Congress EDTF.

exp = [significand]["E"][exponent]

where

[significand] is an integer value of representation [negi];

[exponent] is an integer value of representation [i];

[exp] provides the resulting value of raising the [significand] (a positive or negative integer) to the [exponent] (a positive integer used as a power of 10).

EXAMPLE 1 '3E3' (the value $3 \times 10^3 = 3\ 000$).

EXAMPLE 2 '-82E9' (the value $-82 \times 10^9 = -82\ 000\ 000\ 000$).

A time scale component that accepts unbounded integers (such as calendar year), or is used to describe duration (such as calendar month), can be converted to accept an exponential value using the following representation, where c denotes a time scale component.

c(e) = [c], where the representation of [i] is replaced with [exp]

where

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[c] indicates the time scale component representation;

[e] indicates that the time scale component accepts exponential values.

EXAMPLE 3 If "c" is the time scale component yearE in explicit form, c(e) means "calendar year accepting an exponential value". The explicit year representation [i]["Y"] becomes [exp]["Y"] when [i] is replaced with [exp], and expands to [significand]["E"][exponent]["Y"] and finally [negi]["E"][i]["Y"]. In this representation, the value of [exp] represents a calendar year. '3E8Y' is an expression accepted by this representation.

4.4.3 Significant digits

When a value assigned to a time scale component is large enough, it is often useful to compact the value expression by expressing the precision of the value using the representation as follows. This mechanism originates from Library of Congress EDTF.

sig = [value]["S"][precision]

where

[value] is an integer value that describes the estimated value, represented as [negi];

[precision] is the number of significant digits counting from the leftmost end of [value], describing the precision of the value, represented as [i];

[sig] provides a representation of an estimated value within a value range of specified precision.

EXAMPLE 1 '1230S2', a value between 1200 and 1299, estimated to be 1230.

EXAMPLE 2 '3141592653S4', a value between 3141000000 and 3141999999, estimated to be 3141592653.

EXAMPLE 3 '271828E5S6', a value between 27182800000 and 27182899999, estimated to be 27182800000.

A time scale component that accepts unbounded integers (such as calendar year), or is used to describe duration (such as calendar month), is allowed to accept a value with specified significant digits using the following representation.

c(s) = [c], where the representation of [i] is replaced with [sig]

where

[c] indicates the time scale component representation;

[s] indicates that the time scale component allows significant digits.

EXAMPLE 4 If "c" is the time scale component yearE in explicit form, c(s) means "calendar year accepting a value with significant digits". The explicit year representation [i]["Y"] becomes [sig]["Y"] when [i] is replaced with [sig], and expands to [value]["S"][precision]["Y"] and finally [negi]["S"][i]["Y"]. In this expression, [value] describes the estimated calendar year, [precision] describes the number of digits with precision, and [sig] describes the specified value range. '6633110S3Y' is an expression accepted by this representation.

4.5 Qualification of uncertainty and approximation

This subclause extends time scale components to accept qualification of uncertainty and approximation of their values.

The implicit forms (the "implied form" and "extended form" as described in ISO 8601-1:2019, 4.3) and explicit form (described in 4.3 and ISO 8601-1:2019, 4.3) of time scale components are extended with a qualifying symbol, namely, ["?"], ["~"] or ["%"] (see 3.2.6), according to the following representations:

Implicit:

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c(q) = [!][Q][c]

Explicit:

c(q) = [i][!][Q][symbol(c)]

where [symbol(c)] is the designated symbol for the time scale component.

EXAMPLE If c is the timescale component "year", [symbol(c)] is the symbol for the year time scale component — the designated symbol ["Y"]. If the qualification character is ["?"] and [i] is the value '12', then the representation [i][Q][!][symbol(c)] would accept the expressions '12?Y' or '12Y'.

4.6 Unspecified digits

4.6.1 General

The unspecified value character "X" is used to indicate unspecified digits or values in time scale components.

4.6.2 Unspecified time component value in explicit forms

In explicit forms of time scale components,

— the unspecified value character followed by a "*" ("X*") indicates that the entire value is unspecified;

— the unspecified value character "X" is used as a replacement for any digit in a time scale component value to indicate that the digit is unspecified.

EXAMPLE 1 '195XY' expresses an unspecified calendar year in the 1950s.

EXAMPLE 2 '1390YXXM' expresses a two-digit calendar month in 1390.

EXAMPLE 3 '2052Y1MX*D' expresses some calendar day in January 2052.

EXAMPLE 4 'XXXYX*MXD' expresses a one-digit calendar day of a calendar month in a three-digit calendar year.

EXAMPLE 5 'X*Y12M28D' expresses December 28th of an unspecified calendar year.

4.6.3 Unspecified time component digits in implicit forms

In implicit forms of time scale components, the unspecified value character can be used as a replacement for any digit in a time scale component to indicate that the digit is unspecified. To indicate that the entire component is unspecified, the unspecified value character replaces every digit of that component.

EXAMPLE 1 '199X' expresses an unspecified calendar year in the 1990s.

EXAMPLE 2 '1999-XX' expresses some calendar month in 1999.

EXAMPLE 3 '1999-01-XX' expresses some calendar day in January 1999.

EXAMPLE 4 'XXXX-01-01' expresses January 1st of an unspecified four-digit calendar year.

4.7 Expanded calendar year

4.7.1 General

ISO 8601-1:2019, 5.2.2.3 allows the value of the calendar year time scale component to exceed four digits (a year after 9999 or before -9999). However, this is allowed only by mutual agreement of the communicating parties. This subclause addresses this specific limitation.

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4.7.2 Letter-prefixed calendar year

An alternative time scale component for calendar year, not requiring mutual consent, is provided here as a substitute for the [year] time scale component defined in ISO 8601-1:2019, 3.2.2. It should be used only for dates that include the calendar year only, and only for years later than 9999 or earlier than -9999 (otherwise the representation provided in ISO 8601-1 should be used).

The character "Y" can be used to prefix a string to signify that the element is a calendar year. This time scale component is denoted as [year(p)].

year(p) = ["Y"][negi]

EXAMPLE 1 'Y1700000002' represents a positive calendar year 1700000002.

EXAMPLE 2 'Y-1700000002' represents a negative calendar year -1700000002.

4.7.3 Exponential calendar year

The method of 4.4.2 can be used for representing a year whose value scale is more important than the need for accuracy in conjunction with 4.7.2. This time scale component is denoted as [year(e)].

year(e) = ["Y"][negi]["E"][i]

EXAMPLE 1 'Y17E7' (the calendar year $17 \times 10^7 = 170000000$).

EXAMPLE 2 'Y-17E7' (the calendar year $-17 \times 10^7 = -170000000$).

4.7.4 Significant digits

The method of 4.4.3 can be applied to the year time scale component in conjunction with 4.7.2 as well as 4.7.3. This time scale component is denoted as [year(s)].

The following are acceptable methods to express a calendar year in significant digit representation:

a) Four-digit year that accepts significant digits:

[year(s)]

EXAMPLE 1 '1950S2', some year between 1900 and 1999, estimated to be 1950.

b) Year longer than four digits that is expressed as letter-prefixed and accepts significant digits:

[year(p, s)]

EXAMPLE 2 'Y171010000S3', some year between 171010000 and 171010999, estimated to be 171010000.

c) Year that is expressed in exponential form and accepts significant digits:

[year(p, e, s)]

EXAMPLE 3 'Y3388E2S3', some year between 338000 and 338999, estimated to be 338800.

4.8 Sub-year groupings

4.8.1 Listing of seasons and common sub-year groupings

A sub-year grouping, which is a method of grouping time scale components of a lower order than the year time scale, can be represented as the following values:

— 21 Spring (independent of location)

— 22 Summer (independent of location)

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— 23 Autumn (independent of location)

— 24 Winter (independent of location)

— 25 Spring — Northern Hemisphere

— 26 Summer — Northern Hemisphere

— 27 Autumn — Northern Hemisphere

— 28 Winter — Northern Hemisphere

— 29 Spring — Southern Hemisphere

— 30 Summer — Southern Hemisphere

— 31 Autumn — Southern Hemisphere

— 32 Winter — Southern Hemisphere

— 33 Quarter 1 (3 months in duration)

— 34 Quarter 2 (3 months in duration)

— 35 Quarter 3 (3 months in duration)

— 36 Quarter 4 (3 months in duration)

— 37 Quadrimester 1 (4 months in duration)

— 38 Quadrimester 2 (4 months in duration)

— 39 Quadrimester 3 (4 months in duration)

— 40 Semestral 1 (6 months in duration)

— 41 Semestral 2 (6 months in duration)

The values '21' to '24' indicates a sub-year grouping as seasons, independent of the occurring location.

4.8.2 Groupings represented as time scale components

The following time scale components are used to represent valid ranges of the values in 4.8.1.

a) Implicit, basic sub-year groupings:

season = [AA], where the range is [21] to [24]

b) Implicit, advanced sub-year groupings:

ydivision = [AA], where the range is [21] to [41]

c) Explicit, sub-year groupings:

seasonE = [i]["A"], where [i] is in the range from 21 to 41

4.8.3 Groupings represented as months

In a year-and-month expression (e.g. ISO 8601-1:2019, 5.2.2.2), the calendar month component is extended to accept values specified in 4.8.1 (in addition to calendar month values) to signify sub-year groupings.

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In these representations the month time scale component, [month], is replaced with [season] or [ydivision].

a) Basic seasons in the month time scale component:

[year]["-"][season]

EXAMPLE 1 '2001-21' expresses "Spring of 2001".

b) Hemispheric seasons and typical divisions in the month time scale component:

[year]["-"][ydivision]

EXAMPLE 2 '2001-34' expresses "second quarter of 2001".

5 Grouped time scale units

5.1 General

This clause is a generalization of sub-year groupings described in 4.8.

A time scale unit can be replaced by a "grouped unit" as described in this clause, based on CalConnect CC 18011, Clause 5, "Grouped time scale units".

5.2 Unit definition

A grouped time scale unit ("grouped unit") defines a time scale unit that is a composite of smaller time scale units. Its representation is provided as follows and is denoted as [groupUnit] in this document.

groupUnit = ["G"][durationUnits]["U"]

where

["G"]	is the grouping prefix designator;
["U"]	is the grouping suffix designator;
[durationUnits]	is one or more time scale components for expressing positive duration as specified in 11.2.

NOTE 1 [durationUnits] is essentially a duration statement without the "P" prefix. "P" is unnecessary because the duration is always expressed between the grouping prefix and suffix, namely, “G” and “U”..

NOTE 2 When expressing the month component as a two-digit integer as described in 4.8, this representation does not apply, and the month component can consist entirely of two digits.

Grouped units are continuous; there is no gap between two adjacent grouped units.

EXAMPLE 1 'G11DU', every unit of the grouped unit is of eleven days duration. For example, if this grouped unit replaces the month component in a calendar date, it represents three units of the month: days 1 through 11, days 12 through 22, and days 23 through the end of month, which could be 28, 29, 30 or 31 depending on the actual month the grouping applies to.

NOTE 3 The mechanism for selecting a specific unit from the set of grouped units is specified in 5.3. Thus in this example, if group 1 is selected, it represents the first 11 day period in the month.

EXAMPLE 2 'GT30MU', every unit of the grouped unit is of thirty minutes duration.

EXAMPLE 3 'G2DT6HU', every unit of the grouped unit is of two days and six hours duration.

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5.3 Unit value

The value of a grouped time scale unit is given with the following representation. This representation is denoted as [group] in this document.

group = [i][groupUnit]

where

[i] indicates the coefficient value of the grouped time scale unit;

[groupUnit] is as defined in 5.2.

EXAMPLE 1 '5G10DU', the fifth unit of ten-day groups.

EXAMPLE 2 '20GT30MU', the twentieth unit of thirty-minute groups.

EXAMPLE 3 '2G2DT6HU', the second unit of two-day groups.

The yearly division values from [33] to [41] in 4.8.1 can also be represented in this more generic form.

EXAMPLE 4 The expression '2018-34' is equivalent to the expression '2018-2G3MU' — the second quarter (second three-month period) of 2018.

5.4 Application within representations

5.4.1 General

Grouped time scale units can be applied to date and time representations as replacements for any time scale unit components as long as the resulting expression is a valid one.

EXAMPLE 1 '2018Y4G60DU6D' is a valid date expression that refers to the date year 2018, 6th day of the 4th 60-day group, which is the 186th ordinal day of year (in the Gregorian calendar, the 186th ordinal day is July 5th in a common year and July 6th in a leap year).

EXAMPLE 2 '2018Y9M2DT3GT8HU0H30M' is a valid date and time expression that refers to the date year 2018, September 2nd, 16:30 (30 minutes into the third 8-hour period). While the inner expression '0H' is supplied, it can be omitted in accordance with 7.10.

EXAMPLE 3 '2018-02-2G14DU' (implicit form) and '2018Y2M2G14DU' (explicit form) are complete date expressions that indicate "the second fortnight of February 2018", as specified by the rule "group every 14 days, second group".

EXAMPLE 4 '2018-03-3G10DU' (implicit form) and '2018Y3M3G10DU' (explicit form) are complete date expressions that indicate "the third 10-day block of March in 2018", as specified by the rule "group every 10 days, third group". A 10-day block is a time grouping commonly used in East Asia.

EXAMPLE 5 '16:1GT15MU' (implicit form) and 'T16H1GT15MU' (explicit form) are time expressions that indicate "the first quarter-hour of 16:00", as specified by the rule "group every 15 minutes, first group".

EXAMPLE 6 '2018-1G6MU' (implicit form) and '2018Y1G6MU' (explicit form) are date expressions of six-monthly precision that indicate "the first half of 2018", as specified by the rule "group every 6 months, first group", and therefore the grouping is specified in the [month] field. The resulting time interval is equivalent to the time interval expression '2018-01-01/2018-06-30' and the sub-year grouping expression '2018-40'.

5.4.2 Use of grouped units

Date and time representations can incorporate the grouped time scale units by applying rules from 5.2 and 5.3 to a date and time representation described within this document and ISO 8601-1, by replacing a time scale unit component in the representations with [group].

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The following representation is used for date and time representations (complete representation, reduced precision) that incorporate grouped time scale units. This representation is denoted as [groupDateTime] in this document.

groupDateTime = [higherOrderUnits][group][lowerOrderUnits]

where

[higherOrderUnits] contains time scale units (and their values) that are of higher order compared to the highest order time scale unit within the group unit;

[lowerOrderUnits] is optional, it contains time scale units (and their values) that are of equal or lower order compared to the lowest order time scale unit within the group unit.

EXAMPLE 1 '[monthE][group][yearE]' is an invalid date and time representation as [monthE] has a lower order than that of [yearE].

When [lowerOrderUnits] is omitted, the expression refers to a unit of the grouped time scale unit and therefore has the precision of the grouped time scale unit.

EXAMPLE 2 '[centE][group]' is a valid date and time representation, expressed in units of the grouped time scale unit. '10C5G20YU' is a sample expression of this representation that points to the fifth 20-year unit in the 10th century.

EXAMPLE 3 '1933Y1G80DU' represents the first 80-day group of the year 1933, with a precision of 80-days.

EXAMPLE 4 '1543Y1M3G5DU' refers to the third five-day group in January of the year 1543, with a precision of five-days.

EXAMPLE 5 '110Y2G3MU' refers to the second three-month block of the year 110, which is effectively referring to the second quarter of the year 110, with a precision of three-months.

EXAMPLE 6 '6GT2HU' refers to the sixth two-hour block, with a precision of two-hours.

When [lowerOrderUnits] is present, the expression refers to a date and time using the lowest time scale unit in the [lowerOrderUnits] expression, and therefore has the precision of that time scale.

Time scale components placed to the right of a grouped time scale unit behave identically to those after a typical time scale component, such that the component to the right refers to an instance or time interval "within" the component at the left.

EXAMPLE 7 '[yearE][group][dayE]' is a valid date and time representation, expressed in the calendar day time scale unit. The '[dayE]' points to a calendar day within the expression '[yearE][group]'. '2018Y2G3MU50D' is a sample expression of this representation that points to the 50th day of the second quarter of the year 2018.

EXAMPLE 8 '[decE][group][timeE]' is a valid date and time representation, expressed in the lowest order time scale units specified in [timeE], which is the clock second time scale unit. The '[timeE]' points to a clock time within an expression of '[decE][group]'. '201J2G5YU3DT10H0S' is a sample expression of this representation that includes all the 10:00:00 clock times of the third day of each year of the second five-year block in the 201th decade (spanning years 2010 to 2019). This can be expanded into the time interval set '{ 2015Y3DT10H0S, 2016Y3DT10H0S, 2017Y3DT10H0S, 2018Y3DT10H0S, 2019Y3DT10H0S }'.

EXAMPLE 9 '2018Y3G60DU6D' represents the sixth day within the third 60-day group of the year 2018.

EXAMPLE 10 '2018Y20GT12HU3H' represents the third hour within the twentieth 12-hour group of the year 2018.

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