International Standard

ISO/IEC/IEEE 9945

# Information technology — Portable Operating System Interface (POSIX™) Base Specifications, Issue 8

*Technologies de l'information — Spécifications de base de l'interface pour la portabilité des systèmes (POSIX™), Issue 8*

Second edition
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ISO/IEC/IEEE 9945 was prepared by the Microprocessor Committee of the IEEE Computer Society (as IEEE Std 1003.1-2024) and The Open Group (as The Open Group Technical Standard Base Specifications, Issue 8) and drafted in accordance with its editorial rules. It was adopted, under the “fast-track procedure” defined in the Partner Standards Development Organization cooperation agreement between ISO and IEEE, by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 22, *Programming languages, their environments and system software interfaces*.

This second edition cancels and replaces the first edition (ISO/IEC/IEEE 9945:2009), which has been technically revised. It also incorporates the Technical Corrigenda ISO/IEC/IEEE 9945:2009/Cor. 1:2013 and ISO/IEC/IEEE 9945:2009/Cor. 2:2017.

The main changes are as follows:

— Change history is described in the Rationale (Informative) volume of POSIX.1-2024 and in the CHANGE HISTORY section of reference pages.

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**IEEE Std 1003.1™-2024**
(Revision of IEEE Std 1003.1-2017)

The Open Group Standard, Base Specifications, Issue 8

# IEEE Standard for Information Technology—Portable Operating System Interface (POSIX™)

# Base Specifications, Issue 8

Developed by the

**Microprocessor Committee**
of the
**IEEE Computer Society**

and

**The Open Group**

Approved 20 May 2024

**IEEE SA Standards Board**

IEEE Std 1003.1™-2024 (Revision of IEEE Std 1003.1-2017)
IEEE Standard for Information Technology—Portable Operating System Interface (POSIX®)
The Open Group Standard, Base Specifications, Issue 8

**Abstract:** POSIX.1-2024 is simultaneously IEEE Std 1003.1™-2024 and The Open Group Standard Base Specifications, Issue 8.

POSIX.1-2024 defines a standard operating system interface and environment, including a command interpreter (or "shell"), and common utility programs to support applications portability at the source code level. POSIX.1-2024 is intended to be used by both application developers and system implementors and comprises four major components (each in an associated volume):

- General terms, concepts, and interfaces common to all volumes of this standard, including utility conventions and C-language header definitions, are included in the Base Definitions volume.
- Definitions for system service functions and subroutines, language-specific system services for the C programming language, function issues, including portability, error handling, and error recovery, are included in the System Interfaces volume.
- Definitions for a standard source code-level interface to command interpretation services (a "shell") and common utility programs for application programs are included in the Shell and Utilities volume.
- Extended rationale that did not fit well into the rest of the document structure, which contains historical information concerning the contents of POSIX.1-2024 and why features were included or discarded by the standard developers, is included in the Rationale (Informative) volume.

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The following areas are outside the scope of POSIX.1-2024:

- Graphics interfaces
- Database management system interfaces
- Record I/O considerations
- Object or binary code portability
- System configuration and resource availability

POSIX.1-2024 describes the external characteristics and facilities that are of importance to application developers, rather than the internal construction techniques employed to achieve these capabilities. Special emphasis is placed on those functions and facilities that are needed in a wide variety of commercial applications.

**Keywords:** application program interface (API), argument, asynchronous, basic regular expression (BRE), built-in utility, byte, child, command language interpreter, CPU, extended regular expression (ERE), FIFO, file access control mechanism, IEEE 1003.1™, input/output (I/O), job control, network, parent, portable operating system interface (POSIX™), shell, stream, string, synchronous, system, thread, X/Open System Interface (XSI)

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# Introduction

This introduction is not part of IEEE Std 1003.1™-2024, IEEE Standard for Information Technology—Portable Operating System Interface (POSIX™)—Base Specifications, Issue 8.

This draft standard was developed, and is maintained, by a joint working group of members of the IEEE Microprocessor Standards Committee, members of The Open Group, and members of ISO/IEC Joint Technical Committee 1. This joint working group is known as the Austin Group.[4]

The Austin Group arose out of discussions amongst the parties which started in early 1998, leading to an initial meeting and formation of the group in September 1998. The purpose of the Austin Group is to develop and maintain the core open systems interfaces that are the POSIX 1003.1 (and former 1003.2) standards, ISO/IEC 9945, and the core of the Single UNIX® Specification.

The approach to specification development has been one of "write once, adopt everywhere", with the deliverables being a set of specifications that carry the IEEE POSIX designation, The Open Group Standard designation, and an ISO/IEC designation.

This unique development has combined both the industry-led efforts and the formal standardization activities into a single initiative, and included a wide spectrum of participants. The Austin Group continues as the maintenance body for this document.

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## Background

The developers of POSIX.1-2024 represent a cross-section of hardware manufacturers, vendors of operating systems and other software development tools, software designers, consultants, academics, authors, applications programmers, and others.

Conceptually, POSIX.1-2024 describes a set of fundamental services needed for the efficient construction of application programs. Access to these services has been provided by defining an interface, using the C programming language, a command interpreter, and common utility programs that establish standard semantics and syntax. Since this interface enables application developers to write portable applications – it was developed with that goal in mind – it has been designated POSIX,[5] an acronym for Portable Operating System Interface.

Although originated to refer to the original IEEE Std 1003.1-1988, the name POSIX more correctly refers to a *family* of related standards: IEEE Std 1003.*n* and the parts of ISO/IEC 9945. In earlier editions of the IEEE Standard, the term POSIX was used as a synonym for IEEE Std 1003.1-1988. A preferred term, POSIX.1, emerged. This maintained the advantages of readability of the symbol "POSIX" without being ambiguous with the POSIX family of standards.

[4] The Austin Group is named after the location of the inaugural meeting held at the IBM facility in Austin, Texas in September 1998.

[5] The name POSIX was suggested by Richard Stallman. It is expected to be pronounced with the first two syllables as in positive, not poh-six, or other variations. The pronunciation has been published in an attempt to promulgate a standardized way of referring to a standard operating system interface.

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### Audience

The intended audience for POSIX.1-2024 is all persons concerned with an industry-wide standard operating system based on the UNIX system. This includes at least four groups of people:

- Persons buying hardware and software systems
- Persons managing companies that are deciding on future corporate computing directions
- Persons implementing operating systems, and especially
- Persons developing applications where portability is an objective

### Purpose

Several principles guided the development of POSIX.1-2024:

- Application-Oriented – The basic goal was to promote portability of application programs across UNIX system environments by developing a clear, consistent, and unambiguous standard for the interface specification of a portable operating system based on the UNIX system documentation. POSIX.1-2024 codifies the common, existing definition of the UNIX system.
- Interface, Not Implementation – POSIX.1-2024 defines an interface, not an implementation. No distinction is made between library functions and system calls; both are referred to as functions. No details of the implementation of any function are given (although historical practice is sometimes indicated in the RATIONALE section). Symbolic names are given for constants (such as signals and error numbers) rather than numbers.
- Source, Not Object, Portability – POSIX.1-2024 has been written so that a program written and translated for execution on one conforming implementation may also be translated for execution on another conforming implementation. POSIX.1-2024 does not guarantee that executable (object or binary) code will execute under a different conforming implementation than that for which it was translated, even if the underlying hardware is identical.
- The C Language – The system interfaces and header definitions are written in terms of the standard C language as specified in the ISO C standard.
- No Superuser, No System Administration – There was no intention to specify all aspects of an operating system. System administration facilities and functions are excluded from this standard, and functions usable only by the superuser have not been included. Still, an implementation of the standard interface may also implement features not in POSIX.1-2024. POSIX.1-2024 is also not concerned with hardware constraints or system maintenance.
- Minimal Interface, Minimally Defined – In keeping with the historical design principles of the UNIX system, the mandatory core facilities of POSIX.1-2024 have been kept as minimal as possible. Additional capabilities have been added as optional extensions.
- Broadly Implementable – The developers of POSIX.1-2024 endeavored to make all specified functions implementable across a wide range of existing and potential systems, including:
    - All of the current major systems that are ultimately derived from the original UNIX system code (Version 7 or later)
    - Compatible systems that are not derived from the original UNIX system code
    - Emulations hosted on entirely different operating systems
    - Networked systems
    - Distributed systems


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— Systems running on a broad range of hardware

No direct references to this goal appear in POSIX.1-2024, but some results of it are mentioned in the Rationale (Informative) volume.

- Minimal Changes to Historical Implementations – When the original version – IEEE Std 1003.1-1988 – was published, there were no known historical implementations that did not have to change. However, there was a broad consensus on a set of functions, types, definitions, and concepts that formed an interface that was common to most historical implementations.

  The adoption of the 1988 and 1990 IEEE system interface standards, the 1992 IEEE shell and utilities standard, the various The Open Group (formerly X/Open) specifications, and IEEE Std 1003.1-2001 and its technical corrigenda have consolidated this consensus, and this version reflects the significantly increased level of consensus arrived at since the original versions. The authors of the original versions tried, as much as possible, to follow the principles below when creating new specifications:

  — By standardizing an interface like one in an historical implementation; for example, directories

  — By specifying an interface that is readily implementable in terms of, and backwards-compatible with, historical implementations, such as the extended tar format defined in the pax utility

  — By specifying an interface that, when added to an historical implementation, will not conflict with it; for example, the sigaction() function

  POSIX.1-2024 is specifically not a codification of a particular vendor's product.

  It should be noted that implementations will have different kinds of extensions. Some will reflect "historical usage" and will be preserved for execution of pre-existing applications. These functions should be considered "obsolescent" and the standard functions used for new applications. Some extensions will represent functions beyond the scope of POSIX.1-2024. These need to be used with careful management to be able to adapt to future extensions of POSIX.1-2024 and/or port to implementations that provide these services in a different manner.

- Minimal Changes to Existing Application Code—A goal of POSIX.1-2024 was to minimize additional work for application developers. However, because every known historical implementation will have to change at least slightly to conform, some applications will have to change.

### POSIX.1-2024

POSIX.1-2024 defines the Portable Operating System Interface (POSIX) requirements and consists of the following topics arranged as a series of volumes within the standard:

- Base Definitions
- System Interfaces
- Shell and Utilities
- Rationale (Informative)

### Base Definitions

The Base Definitions volume provides common definitions for this standard, therefore readers should be familiar with it before using the other volumes.

This volume is structured as follows:

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- Chapter 1 is an introduction.
- Chapter 2 defines the conformance requirements.
- Chapter 3 defines general terms used.
- Chapter 4 describes general concepts used.
- Chapter 5 describes the notation used to specify file input and output formats in this volume and the Shell and Utilities volume.
- Chapter 6 describes the portable character set and the process of character set definition.
- Chapter 7 describes the syntax for defining internationalization locales as well as the POSIX locale provided on all systems.
- Chapter 8 describes the use of environment variables for internationalization and other purposes.
- Chapter 9 describes the syntax of pattern matching using regular expressions employed by many utilities and matched by the *regcomp*() and *regexec*() functions.
- Chapter 10 describes files and devices found on all systems.
- Chapter 11 describes the asynchronous terminal interface for many of the functions in the System Interfaces volume and the *stty* utility in the Shell and Utilities volume.
- Chapter 12 describes the policies for command line argument construction and parsing.
- Chapter 13 describes namespace reservation.
- Chapter 14 defines the contents of headers which declare the functions and global variables, and define types, constants, macros, and data structures that are needed by programs using the services provided by the System Interfaces volume.

Comprehensive references are available in the Index.

### System Interfaces

The System Interfaces volume describes the interfaces offered to application programs by POSIX-conformant systems. Readers are expected to be experienced C language programmers, and to be familiar with the Base Definitions volume.

This volume is structured as follows:

- Chapter 1 explains the status of this volume and its relationship to other formal standards.
- Chapter 2 contains important concepts, terms, and caveats relating to the rest of this volume.
- Chapter 3 defines the functional interfaces to the POSIX-conformant system.

Comprehensive references are available in the Index.

### Shell and Utilities

The Shell and Utilities volume describes the commands and utilities offered to application programs on POSIX-conformant systems. Readers are expected to be familiar with the Base Definitions volume.

This volume is structured as follows:


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- Chapter 1 explains the status of this volume and its relationship to other formal standards. It also describes the defaults used by the utility descriptions.
- Chapter 2 describes the command language used in POSIX-conformant systems, and special built-in utilities.
- Chapter 3 consists of reference pages for all utilities, other than the special built-in utilities described in Chapter 2, available on POSIX-conformant systems.

Comprehensive references are available in the Index.

### Rationale (Informative)

The Rationale volume is published to assist in the process of review. It contains historical information concerning the contents of this standard and why features were included or discarded by the standard developers. It also contains notes of interest to application programmers on recommended programming practices, emphasizing the consequences of some aspects of POSIX.1-2024 that may not be immediately apparent.

This volume is organized in parallel to the normative volumes of this standard, with a separate part for each of the three normative volumes.

Within this volume, the following terms are used:

- Base standard—The portions of POSIX.1-2024 that are not optional, equivalent to the definitions of classic POSIX.1 and POSIX.2.
- POSIX.0—Although this term is not used in the normative text of POSIX.1-2024, it is used in this volume to refer to IEEE Std 1003.0-1995.
- POSIX.1b—Although this term is not used in the normative text of POSIX.1-2024, it is used in this volume to refer to the elements of the POSIX Realtime Extension amendment. (This was earlier referred to as POSIX.4 during the standard development process.)
- POSIX.1c—Although this term is not used in the normative text of POSIX.1-2024, it is used in this volume to refer to the POSIX Threads Extension amendment. (This was earlier referred to as POSIX.4a during the standard development process.)
- Standard developers—The individuals and companies in the development organizations responsible for POSIX.1-2024: the IEEE P1003.1 working groups, The Open Group Base working group, advised by the hundreds of individual technical experts who balloted the draft standards within the Austin Group, and the member bodies and technical experts of ISO/IEC JTC 1/SC 22.
- XSI option—The portions of POSIX.1-2024 addressing the extension added for support of the Single UNIX Specification.

### Typographical Conventions

The following typographical conventions are used throughout this standard. In the text, this standard is referred to as POSIX.1-2024, which is technically identical to The Open Group Base Specifications, Issue 8.

The typographical conventions listed here are for ease of reading only. Editorial inconsistencies in the use of typography are unintentional and have no normative meaning in POSIX.1-2024.

| Reference | Example | Notes |
|---|---|---|
| C-Language Data Structure | **aiocb** | |

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| Reference | Example | Notes |
|---|---|---|
| C-Language Data Structure Member | *aio_lio_opcode* | |
| C-Language Data Type | **long** | |
| C-Language External Variable | *errno* | |
| C-Language Function | *system*() | |
| C-Language Function Argument | *arg* | |
| C-Language Function Family | *exec* | |
| C-Language Header | **<sys/stat.h>** | |
| C-Language Keyword | **return** | |
| C-Language Macro with Argument | *assert*() | |
| C-Language Macro with No Argument | NET_ADDRSTRLEN | |
| C-Language Preprocessing Directive | **#define** | |
| Commands within a Utility | **a**, **c** | |
| Conversion Specifier, Specifier/Modifier Character | `%A`, `g`, `E` | 1 |
| Environment Variable | *PATH* | |
| Error Number | [EINTR] | |
| Example Output | **`Hello, World`** | |
| Filename | **/tmp** | |
| Literal Character | `'c'`, `'\r'` | 2 |
| Literal String | `"abcde"` | 2 |
| Optional Items in Utility Syntax | **[ ]** | |
| Parameter | *<directory pathname>* | |
| Special Character | <newline> | 3 |
| Symbolic Constant | _POSIX_VDISABLE | |
| Symbolic Limit, Configuration Value | {LINE_MAX} | 4 |
| Syntax | `#include <sys/stat.h>` | |
| User Input and Example Code | `echo Hello, World` | 5 |
| Utility Name | *awk* | |
| Utility Operand | *file_name* | |
| Utility Option | **-c** | |
| Utility Option with Option-Argument | **-w** *width* | |

Note that:

1. Conversion specifications, specifier characters, and modifier characters are used primarily in date-related functions and utilities and the *fprintf*() and *fscanf*() formatting functions.


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2. Unless otherwise noted, the quotes shall not be used as input or output. When used in a list item, the quotes are omitted. The literal characters <apostrophe> (also known as single-quote) and <backslash> are either shown as the C constants `'\''` and `'\\'`, respectively, or as the special characters <apostrophe>, single-quote, and <backslash> depending on context.

3. The style selected for some of the special characters, such as <newline>, matches the form of the input given to the *localedef* utility. Generally, the characters selected for this special treatment are those that are not visually distinct, such as the control characters <tab> or <newline>.

4. Names surrounded by braces represent symbolic limits or configuration values which may be declared in appropriate headers by means of the C **#define** construct, or obtained at runtime from functions or utilities that return limit or configuration values.

5. Brackets shown in this font, `"[ ]"`, are part of the syntax and do not indicate optional items. In syntax the `'|'` symbol is used to separate alternatives, and ellipses (`"..."`) are used to show that additional arguments are optional.

Shading is used to identify extensions and options.

Footnotes and notes within the body of the normative text are for information only (informative).

Informative sections (such as Rationale, Change History, Application Usage, and so on) are denoted by continuous shading bars in the margins.

Ranges of values are indicated with parentheses or brackets as follows:

1. (*a*,*b*) means the range of all values from *a* to *b*, including neither *a* nor *b*.

2. [*a*,*b*] means the range of all values from *a* to *b*, including *a* and *b*.

3. [*a*,*b*) means the range of all values from *a* to *b*, including *a*, but not *b*.

4. (*a*,*b*] means the range of all values from *a* to *b*, including *b*, but not *a*.

NOTE— A symbolic limit beginning with POSIX is treated differently, depending on context. In a C-language header, the symbol POSIXstring (where string may contain underscores) is represented by the C identifier _POSIXstring, with a leading underscore required to prevent ISO C standard name space pollution. However, in other contexts, such as languages other than C, the leading underscore is not used because this requirement does not exist.

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OSF/1
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OSF AES
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*Referenced Documents*

System V Release 2.0

— UNIX System V Release 2.0 Programmer's Reference Manual (April 1984 - Issue 2).

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*The Open Group Standard*

# Vol. 1:

# Base Definitions, Issue 8

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*Chapter 1*

# *Introduction*

## 1.1 Scope

POSIX.1-2024 defines a standard operating system interface and environment, including a command interpreter (or ``shell''), and common utility programs to support applications portability at the source code level. It is intended to be used by both application developers and system implementors.

POSIX.1-2024 comprises four major components (each in an associated volume):

1. General terms, concepts, and interfaces common to all volumes of POSIX.1-2024, including utility conventions and C-language header definitions, are included in the Base Definitions volume of POSIX.1-2024.
2. Definitions for system service functions and subroutines, language-specific system services for the C programming language, function issues, including portability, error handling, and error recovery, are included in the System Interfaces volume of POSIX.1-2024.
3. Definitions for a standard source code-level interface to command interpretation services (a ``shell'') and common utility programs for application programs are included in the Shell and Utilities volume of POSIX.1-2024.
4. Extended rationale that did not fit well into the rest of the document structure, containing historical information concerning the contents of POSIX.1-2024 and why features were included or discarded by the standard developers, is included in the Rationale (Informative) volume of POSIX.1-2024.

The following areas are outside of the scope of POSIX.1-2024:

- Graphics interfaces
- Database management system interfaces
- Record I/O considerations
- Object or binary code portability
- System configuration and resource availability

POSIX.1-2024 describes the external characteristics and facilities that are of importance to application developers, rather than the internal construction techniques employed to achieve these capabilities. Special emphasis is placed on those functions and facilities that are needed in a wide variety of commercial applications.

The facilities provided in POSIX.1-2024 are drawn from the following base documents:

- IEEE Std 1003.1-2017 (POSIX.1-2017)
- IEEE Std 1003.26-2003 (POSIX.26-2003)

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- ISO/IEC 9899: 2018, Programming Languages — C (C17)
- ISO/IEC TR 24731-2: 2010, Programming languages, their environments and system software interfaces — Extensions to the C library — Part 2: Dynamic Allocation Functions
- The Open Group Standard, 2021, Additional APIs for the Base Specifications Issue 8, Part 1
- The Open Group Standard, 2022, Additional APIs for the Base Specifications Issue 8, Part 2

Emphasis has been placed on standardizing existing practice for existing users, with changes and additions limited to correcting deficiencies in the following areas:

- Issues raised by Austin Group defect reports and IEEE Interpretations against IEEE Std 1003.1.
- Issues raised in corrigenda for The Open Group Standards and working group resolutions from The Open Group
- Changes to make the text self-consistent with the additional material merged
- Features, marked obsolescent in the base documents, have been considered for removal in this version
- Alignment with the ISO/IEC 9899: 2018 standard

## 1.2 Word Usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals *is required to*).[1, 2]

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals *is recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals *is permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals *is able to*).

## 1.3 Conformance

Conformance requirements for POSIX.1-2024 are defined in Chapter 2 (on page 15).

1. The use of the word *must* is deprecated and cannot be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.
2. The use of *will* is deprecated and cannot be used when stating mandatory requirements; *will* is only used in statements of fact.

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## 1.4 Normative References

The following standards contain provisions which, through references in POSIX.1-2024, constitute provisions of POSIX.1-2024. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on POSIX.1-2024 are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/IEC 646: 1991
: ISO/IEC 646: 1991, Information Processing — ISO 7-Bit Coded Character Set for Information Interchange.[3]

ISO 4217: 2015
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ISO 8601-1: 2019
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ISO C (C17)
: ISO/IEC 9899: 2018, Programming Languages — C.

ISO/IEC 10646: 2020
: ISO/IEC 10646: 2020, Information Technology — Universal coded character set (UCS).

## 1.5 Change History

Change history is described in the Rationale (Informative) volume of POSIX.1-2024, and in the CHANGE HISTORY section of reference pages.

## 1.6 Terminology

For the purposes of POSIX.1-2024, the following terminology definitions apply:

**can**
: Describes a permissible optional feature or behavior available to the user or application. The feature or behavior is mandatory for an implementation that conforms to POSIX.1-2024. An application can rely on the existence of the feature or behavior.

**implementation-defined**
: Describes a value or behavior that is not defined by POSIX.1-2024 but is selected by an implementor. The value or behavior may vary among implementations that conform to POSIX.1-2024. An application should not rely on the existence of the value or behavior. An application that relies on such a value or behavior cannot be assured to be portable across conforming implementations.

  The implementor shall document such a value or behavior so that it can be used correctly by an application.

**legacy**
: Describes a feature or behavior that is being retained for compatibility with older applications, but which has limitations which make it inappropriate for developing portable

3. ISO/IEC documents can be obtained from https://www.iso.org/store.html.

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applications. New applications should use alternative means of obtaining equivalent functionality.

**may**
Describes a feature or behavior that is optional for an implementation that conforms to POSIX.1-2024. An application should not rely on the existence of the feature or behavior. An application that relies on such a feature or behavior cannot be assured to be portable across conforming implementations.

To avoid ambiguity, the opposite of *may* is expressed as *need not*, instead of *may not*.

**shall**
For an implementation that conforms to POSIX.1-2024, describes a feature or behavior that is mandatory. An application can rely on the existence of the feature or behavior.

For an application or user, describes a behavior that is mandatory.

**should**
For an implementation that conforms to POSIX.1-2024, describes a feature or behavior that is recommended but not mandatory. An application should not rely on the existence of the feature or behavior. An application that relies on such a feature or behavior cannot be assured to be portable across conforming implementations.

For an application, describes a feature or behavior that is recommended programming practice for optimum portability.

**undefined**
Describes the nature of a value or behavior not defined by POSIX.1-2024 which results from use of an invalid program construct or invalid data input.

The value or behavior may vary among implementations that conform to POSIX.1-2024. An application should not rely on the existence or validity of the value or behavior. An application that relies on any particular value or behavior cannot be assured to be portable across conforming implementations.

**unspecified**
Describes the nature of a value or behavior not specified by POSIX.1-2024 which results from use of a valid program construct or valid data input.

The value or behavior may vary among implementations that conform to POSIX.1-2024. An application should not rely on the existence or validity of the value or behavior. An application that relies on any particular value or behavior cannot be assured to be portable across conforming implementations.

## 1.7 Definitions and Concepts

Definitions and concepts are defined in Chapter 3 (on page 31) and Chapter 4 (on page 95).

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## 1.8 Portability

Some of the utilities in the Shell and Utilities volume of POSIX.1-2024 and functions in the System Interfaces volume of POSIX.1-2024 describe functionality that might not be fully portable to systems meeting the requirements for POSIX conformance (see Chapter 2, on page 15).

Where optional, enhanced, or reduced functionality is specified, the text is shaded and a code in the margin identifies the nature of the option, extension, or warning (see Section 1.8.1). For maximum portability, an application should avoid such functionality.

Unless the primary task of a utility is to produce textual material on its standard output, application developers should not rely on the format or content of any such material that may be produced. Where the primary task *is* to provide such material, but the output format is incompletely specified, the description is marked with the OF margin code and shading. Application developers are warned not to expect that the output of such an interface on one system is any guide to its behavior on another system.

### 1.8.1 Codes

The codes and their meanings are as follows. See also Section 1.8.2 (on page 12).

ADV Advisory Information
The functionality described is optional. The functionality described is also an extension to the ISO C standard.

Where applicable, functions are marked with the ADV margin legend in the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the ADV margin legend.

CD C-Language Development Utilities
The functionality described is optional.

Where applicable, utilities are marked with the CD margin legend in the SYNOPSIS section. Where additional semantics apply to a utility, the material is identified by use of the CD margin legend.

CPT Process CPU-Time Clocks
The functionality described is optional. The functionality described is also an extension to the ISO C standard.

Where applicable, functions are marked with the CPT margin legend in the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the CPT margin legend.

CX Extension to the ISO C standard
The functionality described is an extension to the ISO C standard or a deviation from it. Application developers can make use of the functionality as it is supported on all POSIX.1-2024-conforming systems.

With each function or header from the ISO C standard, a statement is included to the effect that ``any conflict is unintentional'', or ``any other conflict is unintentional'' if there is an intentional conflict (deviation). That is intended to refer to a direct conflict. POSIX.1-2024 acts in part as a profile of the ISO C standard, and it may choose to further constrain behaviors allowed to vary by the ISO C standard. Such limitations and other compatible differences are not considered conflicts, even if a CX mark is missing. The markings are for information only.

Where additional semantics apply to a function or header, the material is identified by use of the CX margin legend.

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DC Device Control
The functionality described is optional. The functionality described is also an extension to the ISO C standard.

Where applicable, functions are marked with the DC margin legend in the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the DC margin legend.

FR FORTRAN Runtime Utilities
The functionality described is optional.

Where applicable, utilities are marked with the FR margin legend in the SYNOPSIS section. Where additional semantics apply to a utility, the material is identified by use of the FR margin legend.

FSC File Synchronization
The functionality described is optional. The functionality described is also an extension to the ISO C standard.

Where applicable, functions are marked with the FSC margin legend in the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the FSC margin legend.

IP6 IPV6
The functionality described is optional. The functionality described is also an extension to the ISO C standard.

Where applicable, functions are marked with the IP6 margin legend in the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the IP6 margin legend.

MC1 Non-Robust Mutex Priority Protection or Non-Robust Mutex Priority Inheritance or Robust Mutex Priority Protection or Robust Mutex Priority Inheritance
The functionality described is optional. The functionality described is also an extension to the ISO C standard.

This is a shorthand notation for combinations of multiple option codes.

Where applicable, functions are marked with the MC1 margin legend in the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the MC1 margin legend.

Refer to Section 1.8.2 (on page 12).

ML Process Memory Locking
The functionality described is optional. The functionality described is also an extension to the ISO C standard.

Where applicable, functions are marked with the ML margin legend in the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the ML margin legend.

MLR Range Memory Locking
The functionality described is optional. The functionality described is also an extension to the ISO C standard.

Where applicable, functions are marked with the MLR margin legend in the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the MLR margin legend.

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MSG **Message Passing**
The functionality described is optional. The functionality described is also an extension to the ISO C standard.

Where applicable, functions are marked with the MSG margin legend in the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the MSG margin legend.

MX **IEC 60559 Floating-Point**
The functionality described is optional. The functionality described is mandated by the ISO C standard only for implementations that define __STDC_IEC_559__.

MXC **IEC 60559 Complex Floating-Point**
The functionality described is optional. The functionality described is mandated by the ISO C standard only for implementations that define __STDC_IEC_559_COMPLEX__.

MXX **IEC 60559 Floating-Point Extension**
The functionality described is optional. The functionality described is part of the IEC 60559 Floating-Point option, but is an extension to the ISO C standard.

OB **Obsolescent**
The functionality described may be removed in a future version of this volume of POSIX.1-2024. Strictly Conforming POSIX Applications and Strictly Conforming XSI Applications shall not use obsolescent features.

Where applicable, the material is identified by use of the OB margin legend.

OF **Output Format Incompletely Specified**
The functionality described is an XSI extension. The format of the output produced by the utility is not fully specified. It is therefore not possible to post-process this output in a consistent fashion. Typical problems include unknown length of strings and unspecified field delimiters.

Where applicable, the material is identified by use of the OF margin legend.

OH **Optional Header**
In the SYNOPSIS section of some interfaces in the System Interfaces volume of POSIX.1-2024 an included header is marked as in the following example:

OH
```
#include <sys/types.h>
#include <fcntl.h>
int open(const char *path, int oflag, ...);
```

The OH margin legend indicates that the optional header defines constants that will be needed if the function is called with certain flag arguments; thus it may be required for some of the functionality described, but is not needed otherwise.

PIO **Prioritized Input and Output**
The functionality described is optional. The functionality described is also an extension to the ISO C standard.

Where applicable, functions are marked with the PIO margin legend in the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the PIO margin legend.

PS **Process Scheduling**
The functionality described is optional. The functionality described is also an extension to the ISO C standard.

Where applicable, functions are marked with the PS margin legend in the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the PS

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278 margin legend.

279 RPI Robust Mutex Priority Inheritance
280 The functionality described is optional. The functionality described is also an extension to the
281 ISO C standard.

282 Where applicable, functions are marked with the RPI margin legend in the SYNOPSIS section.
283 Where additional semantics apply to a function, the material is identified by use of the RPI
284 margin legend.

285 RPP Robust Mutex Priority Protection
286 The functionality described is optional. The functionality described is also an extension to the
287 ISO C standard.

288 Where applicable, functions are marked with the RPP margin legend in the SYNOPSIS section.
289 Where additional semantics apply to a function, the material is identified by use of the RPP
290 margin legend.

291 RS Raw Sockets
292 The functionality described is optional. The functionality described is also an extension to the
293 ISO C standard.

294 Where applicable, functions are marked with the RS margin legend in the SYNOPSIS section.
295 Where additional semantics apply to a function, the material is identified by use of the RS
296 margin legend.

297 SD Software Development Utilities
298 The functionality described is optional.

299 Where applicable, utilities are marked with the SD margin legend in the SYNOPSIS section.
300 Where additional semantics apply to a utility, the material is identified by use of the SD margin
301 legend.

302 SHM Shared Memory Objects
303 The functionality described is optional. The functionality described is also an extension to the
304 ISO C standard.

305 Where applicable, functions are marked with the SHM margin legend in the SYNOPSIS section.
306 Where additional semantics apply to a function, the material is identified by use of the SHM
307 margin legend.

308 SIO Synchronized Input and Output
309 The functionality described is optional. The functionality described is also an extension to the
310 ISO C standard.

311 Where applicable, functions are marked with the SIO margin legend in the SYNOPSIS section.
312 Where additional semantics apply to a function, the material is identified by use of the SIO
313 margin legend.

314 SPN Spawn
315 The functionality described is optional. The functionality described is also an extension to the
316 ISO C standard.

317 Where applicable, functions are marked with the SPN margin legend in the SYNOPSIS section.
318 Where additional semantics apply to a function, the material is identified by use of the SPN
319 margin legend.

320 SS Process Sporadic Server
321 The functionality described is optional. The functionality described is also an extension to the
322 ISO C standard.

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Where applicable, functions are marked with the SS margin legend in the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the SS margin legend.

TCT Thread CPU-Time Clocks

The functionality described is optional. The functionality described is also an extension to the ISO C standard.

Where applicable, functions are marked with the TCT margin legend in the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the TCT margin legend.

TPI Non-Robust Mutex Priority Inheritance

The functionality described is optional. The functionality described is also an extension to the ISO C standard.

Where applicable, functions are marked with the TPI margin legend in the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the TPI margin legend.

TPP Non-Robust Mutex Priority Protection

The functionality described is optional. The functionality described is also an extension to the ISO C standard.

Where applicable, functions are marked with the TPP margin legend in the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the TPP margin legend.

TPS Thread Execution Scheduling

The functionality described is optional. The functionality described is also an extension to the ISO C standard.

Where applicable, functions are marked with the TPS margin legend for the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the TPS margin legend.

TSA Thread Stack Address Attribute

The functionality described is optional. The functionality described is also an extension to the ISO C standard.

Where applicable, functions are marked with the TSA margin legend for the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the TSA margin legend.

TSH Thread Process-Shared Synchronization

The functionality described is optional. The functionality described is also an extension to the ISO C standard.

Where applicable, functions are marked with the TSH margin legend in the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the TSH margin legend.

TSP Thread Sporadic Server

The functionality described is optional. The functionality described is also an extension to the ISO C standard.

Where applicable, functions are marked with the TSP margin legend in the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the TSP margin legend.

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TSS Thread Stack Size Attribute
The functionality described is optional. The functionality described is also an extension to the ISO C standard.

Where applicable, functions are marked with the TSS margin legend in the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the TSS margin legend.

TYM Typed Memory Objects
The functionality described is optional. The functionality described is also an extension to the ISO C standard.

Where applicable, functions are marked with the TYM margin legend in the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the TYM margin legend.

UP User Portability Utilities
The functionality described is optional.

Where applicable, utilities are marked with the UP margin legend in the SYNOPSIS section. Where additional semantics apply to a utility, the material is identified by use of the UP margin legend.

UU UUCP Utilities
The functionality described is optional. The functionality described is also an extension to the ISO C standard.

Where applicable, functions are marked with the UU margin legend in the SYNOPSIS section. Where additional semantics apply to a function, the material is identified by use of the UU margin legend.

XSI X/Open System Interfaces
The functionality described is part of the X/Open Systems Interfaces option. Functionality marked XSI is an extension to the ISO C standard. Application developers may confidently make use of such extensions on all systems supporting the X/Open System Interfaces option.

If an entire SYNOPSIS section is shaded and marked XSI, all the functionality described in that reference page is an extension. See Section 2.1.4 (on page 19).

### 1.8.2 Margin Code Notation

Some of the functionality described in POSIX.1-2024 depends on support of more than one option, or independently may depend on several options. The following notation for margin codes is used to denote the following cases.

**A Feature Dependent on One or Two Options**

In this case, margin codes have a <space> separator; for example:

SHM This feature requires support for only the Shared Memory Objects option.

SHM TYM This feature requires support for both the Shared Memory Objects option and the Typed Memory Objects option; that is, an application which uses this feature is portable only between implementations that provide both options.

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**A Feature Dependent on Either of the Options Denoted**

In this case, margin codes have a '|' separator to denote the logical OR; for example:

SHM|TYM This feature is dependent on support for either the Shared Memory Objects option or the Typed Memory Objects option; that is, an application which uses this feature is portable between implementations that provide any (or all) of the options.

**A Feature Dependent on More than Two Options**

The following shorthand notations are used:

MC1 The MC1 margin code is shorthand for TPP|TPI|RPP|RPI. Features which are shaded with this margin code require support of either the Non-Robust Mutex Priority Protection option or the Non-Robust Mutex Priority Inheritance option or the Robust Mutex Priority Protection option or the Robust Mutex Priority Inheritance option.

**Large Sections Dependent on an Option**

Where large sections of text are dependent on support for an option, a lead-in text block is provided and shaded accordingly; for example:

XSI This section describes extensions to support interprocess communication. The functionality described in this section shall be provided on implementations that support the XSI option (and the rest of this section is not further shaded).

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