

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

## Base Specifications, Issue 7

IEEE Computer Society

and

The Open Group

Sponsored by the  
Portable Applications Standards Committee

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IEEE  
3 Park Avenue  
New York, NY 10016-5997  
USA

**IEEE Std 1003.1™, 2016 Edition**  
(incorporates IEEE Std 1003.1-2008,  
IEEE Std 1003.1-2008/Cor 1-2013,  
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The Open Group Standard, Base Specifications, Issue 7  
incorporates IEEE Std 1003.1™-2008,  
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and IEEE Std 1003.1™-2008/Cor 2-2016

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

## Base Specifications, Issue 7

Sponsor

**Portable Applications Standards Committee**

of the

**IEEE Computer Society**

and

**The Open Group**



## Abstract

POSIX.1-2008 is simultaneously IEEE Std 1003.1™-2008 and The Open Group Standard Base Specifications, Issue 7. This 2016 Edition includes IEEE Std 1003.1-2008/Cor 1-2013 and IEEE Std 1003.1-2008/Cor 2-2016 incorporated into IEEE Std 1003.1-2008 (the base document). The Technical Corrigenda address problems discovered since the approval of IEEE Std 1003.1-2008.

POSIX.1-2008 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.1-2008 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.1-2008 and why features were included or discarded by the standard developers, is included in the Rationale (Informative) volume.

The following areas are outside the scope of POSIX.1-2008:

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

POSIX.1-2008 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), batch job, batch system, 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)

The Institute of Electrical and Electronics Engineers, Inc.  
3 Park Avenue, New York, NY 10016-5997, USA

The Open Group  
Apex Plaza, Forbury Road, Reading, Berkshire RG1 1AX, UK

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Please be advised IEEE Std 1003.1, 2016 Edition is for convenience of the user only. It does not supersede the individual published documents listed below:

IEEE Std 1003.1™-2008, Standard for Information Technology—Portable Operating System Interface (POSIX®)

IEEE Std 1003.1™-2008/Cor 1-2013, IEEE Standard for Information Technology—Portable Operating System Interface (POSIX®), Technical Corrigendum 1

IEEE Std 1003.1™-2008/Cor 2-2016, IEEE Standard for Information Technology—Portable Operating System Interface (POSIX®), Technical Corrigendum 2

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Richard Hansen	James C. Pugsley	Michael Wilson
Mark Harris	Yury Pukhalsky	André Zepezauer
Cyril Hrubis	Steve Rago	Mark Ziegast
Jarmo Jaakkola	Chet Ramey	
Felix Janda	Martin Řehák	

## Austin Group Working Group Members

Eitan Adler	Philip Guenther	James C. Pugsley
Iwan Aucamp	Joseph M. Gwinn	Yury Pukhalsky
Bogdan Barbu	Bruno Haible	Steve Rago
David Bartley	Richard Hansen	Chet Ramey
Steve Bartolomei	Mark Harris	Martin Řehák
Fabrice Bauzac	Barry E. Hedquist	Tom Ridge
Guido Berhoerster	David Holland	Torvald Riegel
Eric Blake	Tom Honermann	Xavier Roche
Harvey Block	Cyril Hrubis	Askar Safin
Hans Boehm	Jarmo Jaakkola	Anton Salikhmetov

Bill Bogstad  
Pádraig Brady  
Davide Brini  
Andries E. Brouwer  
Mark S. Brown  
David Butenhof  
Milan Cermak  
Stephane Chazelas  
Alexander Cherepanov  
Mark Clancy  
Geoff Clare  
David Clissold  
Alan Coopersmith  
Donald W. Cragun  
Martijn Dekker  
Matthew Dempsky  
Thomas E. Dickey  
Casper Dik  
Dan Douglas  
Niall Douglas  
Ulrich Drepper  
Lawrence D.K.B. Dwyer  
Paul Eggert  
Daniel Eischen  
Robert Elz  
Steve Emmerson  
Laszlo Ersek  
Bruce Evans  
David Egan Evans  
Roger Faulkner  
Richard Felker  
Jeffrey K. Fellin  
Hal Finkel  
Glenn Fowler  
Cathy Fox  
Mike Frysinger  
Andrea Giugliano  
Thorsten Glaser  
Glenn D. Golden  
Jim Grisanzio

Felix Janda  
Aurelio Jargas  
Ross Johnson  
Andrew Josey  
John Kearney  
Dan Kegel  
Michael Kerrisk  
Rob King  
Tomas Klacko  
Andi Kleen  
Bruce Korb  
David Korn  
Kaz Kylheku  
Rob Landley  
Antoine Leca  
Vincent Lefèvre  
Sean Leonard  
Wojtek Lerch  
Yonggang Luo  
Scott Lurndal  
Roger Marquis  
Sven Mascheck  
Per Mildner  
Margot Hackett Miller  
Joseph S. Myers  
Szabolcs Nagy  
Alexander Nasonov  
Jonathan Nieder  
Danny Niu  
Gian Ntzik  
Steffen Nurpmeso  
Carlos O'Donnell  
Isabella Parakiss  
Vladimir Támara Patiño  
Phil Pénock  
Andres Perera  
Peter Petrov  
William Pitcock  
Wayne Pollock  
Jim Pryor

Jörg Schilling  
Ed Schouten  
Konrad Schwarz  
Ingo Schwarze  
Jens Schweikhardt  
Mike Scudder  
Martin Sebor  
Glen Seeds  
Jeffrey Sheinberg  
Thor Lancelot Simon  
Keld Simonsen  
Ranjit Singh  
Paul Smith  
Steven Stewart-Gallus  
Nicholas M. Stoughton  
Alfred M. Szmidt  
Marcel Telka  
Donn Terry  
Keith Thompson  
Jilles Tjoelker  
William Toth  
Daniel Trebbien  
Miloslav Trmac  
Fred J. Tydeman  
Ted Unangst  
Brian Utterback  
Stijn van Drongelen  
Christopher Vance  
Jonathan Wakely  
Nathan Weeks  
Florian Weimer  
David A. Wheeler  
Mats D. Wichmann  
Michael Wilson  
Garrett Wollman  
Jörg Wunsch  
James Youngman  
André Zepezauer  
Mark Ziegast

## **The Open Group**

When The Open Group approved the Base Specifications, Issue 7, Technical Corrigendum 2 on 20 June 2016, the membership of The Open Group Base Working Group was as follows:

**Andrew Josey**, Chair

**Roger Faulkner**, Austin Group Liaison

**Cathy Fox**, Technical Editor

## **Base Working Group Members**

Eric Blake  
Geoff Clare  
David Clissold

Donald W. Cragun  
Roger Faulkner  
Darrin Johnson

Andrew Josey  
Martin Řehák  
S. R. Srinivasan

## IEEE

At the time this standard was submitted to the IEEE-SA Standards Board for approval, the Portable Applications Standards Committee had the following membership:

**Joseph M. Gwinn**, Chair  
**Andrew Josey**, Functional Chair (Interpretations)  
**Donald W. Cragun**, Shell and Utilities Working Group Chair  
**Barry Hedquist**, Test Methods Working Group Chair  
**Craig Meyers**, Distributed Services Working Group Chair  
**Stephen Walli**, US TAG Institutional Representative  
**Roger Martin**, Ex-officio Emeritus  
**Nicholas M. Stoughton**, Secretary

The following members of the individual balloting committee voted on this. Balloters may have voted for approval, disapproval, or abstention.

Johann Amsenga	Randall Groves	Kenneth Lang
Juan Carreon	Joseph M. Gwinn	Vincent Lefèvre
Keith Chow	Barry E. Hedquist	Peter Petrov
Donald W. Cragun	Werner Hoelzl	Stephen Schwarm
Sourav Dutta	Noriyuki Ikeuchi	Walter Struppler
Andrew Fieldsend	Andrew Josey	Mark-Rene Uchida
David Fuschi	Piotr Karocki	Oren Yuen

When the IEEE-SA Standards Board approved this standard on 30 June 2016, it had the following membership:

**Jean-Philippe Faure**, *Chair*  
**Ted Burse**, *Vice Chair*  
**John D. Kulick**, *Past Chair*  
**Konstantinos Karachalios**, *Secretary*

Chuck Adams	Michael Janezic	Yingli Wen
Masayuki Ariyoshi	Joseph L. Koepfinger*	Howard Wolfman
Stephen Dukes	Hung Ling	Don Wright
Jianbin Fan	Kevin Lu	Yu Yuan
J. Travis Griffith	Annette D. Reilly	Daidi Zhong
Ronald W. Hotchkiss	Gary Robinson	
Gary Hoffman	Mehmet Ulema	

\* Member Emeritus

## Introduction

This introduction is not part of IEEE Std 1003.1, 2016 Edition, Standard for Information Technology – Portable Operating System Interface (POSIX).

This standard was developed, and is maintained, by a joint working group of members of the IEEE Portable Applications 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.<sup>A</sup>

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<sup>®</sup> 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.

Anyone wishing to participate in the Austin Group should contact the chair with their request. There are no fees for participation or membership. You may participate as an observer or as a contributor. You do not have to attend face-to-face meetings to participate; electronic participation is most welcome. For more information on the Austin Group and how to participate, see [www.opengroup.org/austin](http://www.opengroup.org/austin).

## Background

The developers of POSIX.1-2008 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.1-2008 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<sup>B</sup>, 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.

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<sup>A</sup> The Austin Group is named after the location of the inaugural meeting held at the IBM facility in Austin, Texas in September 1998.

<sup>B</sup> The Name POSIX was suggested by Richard Stallman. It is expected to be pronounced *pahz-icks*, 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.

## Audience

The intended audience for POSIX.1-2008 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.1-2008:

- **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.1-2008 codifies the common, existing definition of the UNIX system.
- **Interface, Not Implementation** – POSIX.1-2008 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.1-2008 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.1-2008 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.1-2008. POSIX.1-2008 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.1-2008 have been kept as minimal as possible. Additional capabilities have been added as optional extensions.
- **Broadly Implementable** – The developers of POSIX.1-2008 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
  - Systems running on a broad range of hardwareNo direct references to this goal appear in POSIX.1-2008, 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 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.1-2008 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.1-2008. These need to be used with careful management to be able to adapt to future extensions of POSIX.1-2008 and/or port to implementations that provide these services in a different manner.

- Minimal Changes to Existing Application Code – A goal of POSIX.1-2008 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.1-2008

POSIX.1-2008 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:

- 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 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:

- 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 describes a set of services and utilities that are implemented on systems supporting the Batch Environment Services and Utilities option.
- Chapter 4 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.1-2008 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.1-2008 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.1-2008, 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.1-2008, 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.1-2008, 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.1-2008: 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.1-2008 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.1-2008, which is technically identical to The Open Group Base Specifications, Issue 7.

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.1-2008.

Reference	Example	Notes
C-Language Data Structure	<b>aiocb</b>	
C-Language Data Structure Member	<i>aio_lio_opcode</i>	
C-Language Data Type	<b>long</b>	
C-Language External Variable	<i>errno</i>	
C-Language Function	<i>system()</i>	
C-Language Function Argument	<i>arg</i>	
C-Language Function Family	<i>exec</i>	
C-Language Header	<b>&lt;sys/stat.h&gt;</b>	
C-Language Keyword	<b>return</b>	
C-Language Macro with Argument	<i>assert()</i>	
C-Language Macro with No Argument	NET_ADDRSTRLEN	
C-Language Preprocessing Directive	<b>#define</b>	
Commands within a Utility	<b>a, c</b>	
Conversion Specifier, Specifier/Modifier Character	%A, g, E	1
Environment Variable	<i>PATH</i>	
Error Number	[EINTR]	
Example Output	<b>Hello, World</b>	

Reference	Example	Notes
Filename	<code>/tmp</code>	
Literal Character	<code>'c', '\r'</code>	2
Literal String	<code>"abcde"</code>	2
Optional Items in Utility Syntax	<code>[ ]</code>	
Parameter	<code>&lt;directory pathname&gt;</code>	
Special Character	<code>&lt;newline&gt;</code>	3
Symbolic Constant	<code>_POSIX_VDISABLE</code>	
Symbolic Limit, Configuration Value	<code>{LINE_MAX}</code>	4
Syntax	<code>#include &lt;sys/stat.h&gt;</code>	
User Input and Example Code	<code>echo Hello, World</code>	5
Utility Name	<code>awk</code>	
Utility Operand	<code>file_name</code>	
Utility Option	<code>-c</code>	
Utility Option with Option-Argument	<code>-w width</code>	

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.
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.
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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# Referenced Documents

## Normative References

Normative references for POSIX.1-2008 are defined in [Section 1.3](#) (on page 4).

## Informative References

The following documents are referenced in POSIX.1-2008:

1984 /usr/group Standard

/usr/group Standards Committee, Santa Clara, CA, UniForum 1984.

Almasi and Gottlieb

George S. Almasi and Allan Gottlieb, *Highly Parallel Computing*, The Benjamin/Cummings Publishing Company, Inc., 1989, ISBN: 0-8053-0177-1.

ANSI C

American National Standard for Information Systems: Standard X3.159-1989, Programming Language C.

ANSI X3.226-1994

American National Standard for Information Systems: Standard X3.226-1994, Programming Language Common LISP.

Brawer

Steven Brawer, *Introduction to Parallel Programming*, Academic Press, 1989, ISBN: 0-12-128470-0.

DeRemer and Pennello Article

DeRemer, Frank and Pennello, Thomas J., *Efficient Computation of LALR(1) Look-Ahead Sets*, SigPlan Notices, Volume 15, No. 8, August 1979.

Draft ANSI X3J11.1

IEEE Floating Point draft report of ANSI X3J11.1 (NCEG).

FIPS 151-1

Federal Information Procurement Standard (FIPS) 151-1. Portable Operating System Interface (POSIX)—Part 1: System Application Program Interface (API) [C Language].

FIPS 151-2

Federal Information Procurement Standards (FIPS) 151-2, Portable Operating System Interface (POSIX)— Part 1: System Application Program Interface (API) [C Language].

HP-UX Manual

Hewlett-Packard HP-UX Release 9.0 Reference Manual, Third Edition, August 1992.

IEC 60559: 1989

IEC 60559: 1989, Binary Floating-Point Arithmetic for Microprocessor Systems (previously designated IEC 559: 1989).

IEEE Standards Terms

IEEE 100, The Authoritative Dictionary of IEEE Standards Terms, Seventh Edition.

- IEEE Std 754<sup>TM</sup>-1985  
IEEE Std 754-1985 (Reaff 1990), IEEE Standard for Binary Floating-Point Arithmetic.
- IEEE Std 854<sup>TM</sup>-1987  
IEEE Std 854-1987, IEEE Standard for Radix-Independent Floating-Point Arithmetic.
- IEEE Std 1003.9<sup>TM</sup>-1992  
IEEE Std 1003.9-1992, IEEE Standard for Information Technology — POSIX FORTRAN 77 Language Interfaces — Part 1: Binding for System Application Program Interface API.
- IETF RFC 791  
Internet Protocol, Version 4 (IPv4), September 1981 (available at: [www.ietf.org/rfc/rfc0791.txt](http://www.ietf.org/rfc/rfc0791.txt)).
- IETF RFC 819  
The Domain Naming Convention for Internet User Applications, Z. Su, J. Postel, August 1982 (available at: [www.ietf.org/rfc/rfc0819.txt](http://www.ietf.org/rfc/rfc0819.txt)).
- IETF RFC 822  
Standard for the Format of ARPA Internet Text Messages, D.H. Crocker, August 1982 (available at: [www.ietf.org/rfc/rfc0822.txt](http://www.ietf.org/rfc/rfc0822.txt)).
- IETF RFC 919  
Broadcasting Internet Datagrams, J. Mogul, October 1984 (available at: [www.ietf.org/rfc/rfc0919.txt](http://www.ietf.org/rfc/rfc0919.txt)).
- IETF RFC 920  
Domain Requirements, J. Postel, J. Reynolds, October 1984 (available at: [www.ietf.org/rfc/rfc0920.txt](http://www.ietf.org/rfc/rfc0920.txt)).
- IETF RFC 921  
Domain Name System Implementation Schedule, J. Postel, October 1984 (available at: [www.ietf.org/rfc/rfc0921.txt](http://www.ietf.org/rfc/rfc0921.txt)).
- IETF RFC 922  
Broadcasting Internet Datagrams in the Presence of Subnets, J. Mogul, October 1984 (available at: [www.ietf.org/rfc/rfc0922.txt](http://www.ietf.org/rfc/rfc0922.txt)).
- IETF RFC 1034  
Domain Names — Concepts and Facilities, P. Mockapetris, November 1987 (available at: [www.ietf.org/rfc/rfc1034.txt](http://www.ietf.org/rfc/rfc1034.txt)).
- IETF RFC 1035  
Domain Names — Implementation and Specification, P. Mockapetris, November 1987 (available at: [www.ietf.org/rfc/rfc1035.txt](http://www.ietf.org/rfc/rfc1035.txt)).
- IETF RFC 1123  
Requirements for Internet Hosts — Application and Support, R. Braden, October 1989 (available at: [www.ietf.org/rfc/rfc1123.txt](http://www.ietf.org/rfc/rfc1123.txt)).
- IETF RFC 1886  
DNS Extensions to Support Internet Protocol, Version 6 (IPv6), C. Huitema, S. Thomson, December 1995 (available at: [www.ietf.org/rfc/rfc1886.txt](http://www.ietf.org/rfc/rfc1886.txt)).
- IETF RFC 2045  
Multipurpose Internet Mail Extensions (MIME), Part 1: Format of Internet Message Bodies, N. Freed, N. Borenstein, November 1996 (available at: [www.ietf.org/rfc/rfc2045.txt](http://www.ietf.org/rfc/rfc2045.txt)).

## *Referenced Documents*

### IETF RFC 2181

Clarifications to the DNS Specification, R. Elz, R. Bush, July 1997 (available at: [www.ietf.org/rfc/rfc2181.txt](http://www.ietf.org/rfc/rfc2181.txt)).

### IETF RFC 2373

Internet Protocol, Version 6 (IPv6) Addressing Architecture, S. Deering, R. Hinden, July 1998 (available at: [www.ietf.org/rfc/rfc2373.txt](http://www.ietf.org/rfc/rfc2373.txt)).

### IETF RFC 2460

Internet Protocol, Version 6 (IPv6), S. Deering, R. Hinden, December 1998 (available at: [www.ietf.org/rfc/rfc2460.txt](http://www.ietf.org/rfc/rfc2460.txt)).

### Internationalisation Guide

Guide, July 1993, Internationalisation Guide, Version 2 (ISBN: 1-859120-02-4, G304), published by The Open Group.

### ISO 2375: 1985

ISO 2375: 1985, Data Processing — Procedure for Registration of Escape Sequences.

### ISO 8652: 1987

ISO 8652: 1987, Programming Languages — Ada (technically identical to ANSI standard 1815A-1983).

### ISO/IEC 1539: 1991

ISO/IEC 1539: 1991, Information Technology — Programming Languages — Fortran (technically identical to the ANSI X3.9-1978 standard [FORTRAN 77]).

### ISO/IEC 4873: 1991

ISO/IEC 4873: 1991, Information Technology — ISO 8-bit Code for Information Interchange — Structure and Rules for Implementation.

### ISO/IEC 6429: 1992

ISO/IEC 6429: 1992, Information Technology — Control Functions for Coded Character Sets.

### ISO/IEC 6937: 1994

ISO/IEC 6937: 1994, Information Technology — Coded Graphic Character Set for Text Communication — Latin Alphabet.

### ISO/IEC 8802-3: 1996

ISO/IEC 8802-3: 1996, Information Technology — Telecommunications and Information Exchange Between Systems — Local and Metropolitan Area Networks — Specific Requirements — Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.

### ISO/IEC 8859

ISO/IEC 8859, Information Technology — 8-Bit Single-Byte Coded Graphic Character Sets:

Part 1: Latin Alphabet No. 1

Part 2: Latin Alphabet No. 2

Part 3: Latin Alphabet No. 3

Part 4: Latin Alphabet No. 4

Part 5: Latin/Cyrillic Alphabet

Part 6: Latin/Arabic Alphabet

Part 7: Latin/Greek Alphabet

Part 8: Latin/Hebrew Alphabet

Part 9: Latin Alphabet No. 5

Part 10: Latin Alphabet No. 6

Part 11: Latin/Thai Alphabet

- Part 13: Latin Alphabet No. 7
- Part 14: Latin Alphabet No. 8 (Celtic)
- Part 15: Latin Alphabet No. 9
- Part 16: Latin Alphabet No. 10

ISO/IEC 9899:1990

ISO/IEC 9899:1990, Programming Languages — C, including Amendment 1:1995 (E), C Integrity (Multibyte Support Extensions (MSE) for ISO C).

ISO POSIX-1:1996

ISO/IEC 9945-1:1996, Information Technology — Portable Operating System Interface (POSIX) — Part 1: System Application Program Interface (API) [C Language] (identical to ANSI/IEEE Std 1003.1-1996). Incorporating ANSI/IEEE Stds 1003.1-1990, 1003.1b-1993, 1003.1c-1995, and 1003.1i-1995.

ISO POSIX-2:1993

ISO/IEC 9945-2:1993, Information Technology — Portable Operating System Interface (POSIX) — Part 2: Shell and Utilities (identical to ANSI/IEEE Std 1003.2<sup>TM</sup>-1992, as amended by ANSI/IEEE Std 1003.2a<sup>TM</sup>-1992).

Issue 1

X/Open Portability Guide, July 1985 (ISBN: 0-444-87839-4).

Issue 2

X/Open Portability Guide, January 1987:

- Volume 1: XVS Commands and Utilities (ISBN: 0-444-70174-5)
- Volume 2: XVS System Calls and Libraries (ISBN: 0-444-70175-3)

Issue 3

X/Open Specification, 1988, 1989, February 1992:

- Commands and Utilities, Issue 3 (ISBN: 1-872630-36-7, C211); this specification was formerly X/Open Portability Guide, Issue 3, Volume 1, January 1989, XSI Commands and Utilities (ISBN: 0-13-685835-X, XO/XPG/89/002)
- System Interfaces and Headers, Issue 3 (ISBN: 1-872630-37-5, C212); this specification was formerly X/Open Portability Guide, Issue 3, Volume 2, January 1989, XSI System Interface and Headers (ISBN: 0-13-685843-0, XO/XPG/89/003)
- Curses Interface, Issue 3, contained in Supplementary Definitions, Issue 3 (ISBN: 1-872630-38-3, C213), Chapters 9 to 14 inclusive; this specification was formerly X/Open Portability Guide, Issue 3, Volume 3, January 1989, XSI Supplementary Definitions (ISBN: 0-13-685850-3, XO/XPG/89/004)
- Headers Interface, Issue 3, contained in Supplementary Definitions, Issue 3 (ISBN: 1-872630-38-3, C213), Chapter 19, Cpio and Tar Headers; this specification was formerly X/Open Portability Guide Issue 3, Volume 3, January 1989, XSI Supplementary Definitions (ISBN: 0-13-685850-3, XO/XPG/89/004)

Issue 4

CAE Specification, July 1992, published by The Open Group:

- System Interface Definitions (XBD), Issue 4 (ISBN: 1-872630-46-4, C204)
- Commands and Utilities (XCU), Issue 4 (ISBN: 1-872630-48-0, C203)
- System Interfaces and Headers (XSH), Issue 4 (ISBN: 1-872630-47-2, C202)

## Referenced Documents

### Issue 4, Version 2

CAE Specification, August 1994, published by The Open Group:

- System Interface Definitions (XBD), Issue 4, Version 2 (ISBN: 1-85912-036-9, C434)
- Commands and Utilities (XCU), Issue 4, Version 2 (ISBN: 1-85912-034-2, C436)
- System Interfaces and Headers (XSH), Issue 4, Version 2 (ISBN: 1-85912-037-7, C435)

### Issue 5

Technical Standard, February 1997, published by The Open Group:

- System Interface Definitions (XBD), Issue 5 (ISBN: 1-85912-186-1, C605)
- Commands and Utilities (XCU), Issue 5 (ISBN: 1-85912-191-8, C604)
- System Interfaces and Headers (XSH), Issue 5 (ISBN: 1-85912-181-0, C606)

### Issue 6

Technical Standard, April 2004, published by The Open Group:

- Base Definitions (XBD), Issue 6 (ISBN: 1-931624-43-7, C046)
- System Interfaces (XSH), Issue 6 (ISBN: 1-931624-44-5, C047)
- Shell and Utilities (XCU), Issue 6 (ISBN: 1-931624-45-3, C048)

### Knuth Article

Knuth, Donald E., *On the Translation of Languages from Left to Right*, Information and Control, Volume 8, No. 6, October 1965.

### KornShell

Bolsky, Morris I. and Korn, David G., *The New KornShell Command and Programming Language*, March 1995, Prentice Hall.

### MSE Working Draft

Working draft of ISO/IEC 9899:1990/Add3:Draft, Addendum 3 — Multibyte Support Extensions (MSE) as documented in the ISO Working Paper SC22/WG14/N205 dated 31 March 1992.

### POSIX.0:1995

IEEE Std 1003.0™-1995, IEEE Guide to the POSIX Open System Environment (OSE) (identical to ISO/IEC TR 14252).

### POSIX.1:1988

IEEE Std 1003.1™-1988, IEEE Standard for Information Technology — Portable Operating System Interface (POSIX) — Part 1: System Application Program Interface (API) [C Language].

### POSIX.1:1990

IEEE Std 1003.1™-1990, IEEE Standard for Information Technology — Portable Operating System Interface (POSIX) — Part 1: System Application Program Interface (API) [C Language].

### POSIX.1a

P1003.1a, Standard for Information Technology — Portable Operating System Interface (POSIX) — Part 1: System Application Program Interface (API) — (C Language) Amendment.

### POSIX.1d:1999

IEEE Std 1003.1d™-1999, IEEE Standard for Information Technology — Portable Operating System Interface (POSIX) — Part 1: System Application Program Interface (API) —

- Amendment 4: Additional Realtime Extensions [C Language].
- POSIX.1g: 2000  
IEEE Std 1003.1g™-2000, IEEE Standard for Information Technology — Portable Operating System Interface (POSIX) — Part 1: System Application Program Interface (API) — Amendment 6: Protocol-Independent Interfaces (PII).
- POSIX.1j: 2000  
IEEE Std 1003.1j™-2000, IEEE Standard for Information Technology — Portable Operating System Interface (POSIX) — Part 1: System Application Program Interface (API) — Amendment 5: Advanced Realtime Extensions [C Language].
- POSIX.1q: 2000  
IEEE Std 1003.1q™-2000, IEEE Standard for Information Technology — Portable Operating System Interface (POSIX) — Part 1: System Application Program Interface (API) — Amendment 7: Tracing [C Language].
- POSIX.2: 1992  
IEEE Std 1003.2™-1992, IEEE Standard for Information Technology — Portable Operating System Interface (POSIX) — Part 2: Shell and Utilities.
- POSIX.2b  
P1003.2b, Standard for Information Technology — Portable Operating System Interface (POSIX) — Part 2: Shell and Utilities — Amendment.
- POSIX.2d: 1994  
IEEE Std 1003.2d™-1994, IEEE Standard for Information Technology — Portable Operating System Interface (POSIX) — Part 2: Shell and Utilities — Amendment 1: Batch Environment.
- POSIX.13: 1998  
IEEE Std 1003.13™-1998, IEEE Standard for Information Technology — Standardized Application Environment Profile (AEP) — POSIX Realtime Application Support.
- Sarwate Article  
Sarwate, Dilip V., *Computation of Cyclic Redundancy Checks via Table Lookup*, Communications of the ACM, Volume 30, No. 8, August 1988.
- Sprunt, Sha, and Lehoczky  
Sprunt, B., Sha, L., and Lehoczky, J.P., *Aperiodic Task Scheduling for Hard Real-Time Systems*, The Journal of Real-Time Systems, Volume 1, 1989, Pages 27-60.
- SVID, Issue 1  
American Telephone and Telegraph Company, System V Interface Definition (SVID), Issue 1; Morristown, NJ, UNIX Press, 1985.
- SVID, Issue 2  
American Telephone and Telegraph Company, System V Interface Definition (SVID), Issue 2; Morristown, NJ, UNIX Press, 1986.
- SVID, Issue 3  
American Telephone and Telegraph Company, System V Interface Definition (SVID), Issue 3; Morristown, NJ, UNIX Press, 1989.
- The AWK Programming Language  
Aho, Alfred V., Kernighan, Brian W., and Weinberger, Peter J., *The AWK Programming Language*, Reading, MA, Addison-Wesley 1988.
- The C Programming Language  
Kernighan, Brian W. and Ritchie, Dennis M., *The C Programming Language*, Englewood Cliffs, NJ, Prentice Hall, 1st Edition (February 1978) ISBN 0-13-110163-3; 2nd Edition (March

## Referenced Documents

- 1988) ISBN 0-13-110362-8.
- UNIX Programmer's Manual  
American Telephone and Telegraph Company, *UNIX Time-Sharing System: UNIX Programmer's Manual*, 7th Edition, Murray Hill, NJ, Bell Telephone Laboratories, January 1979.
- XNS, Issue 4  
CAE Specification, August 1994, Networking Services, Issue 4 (ISBN: 1-85912-049-0, C438), published by The Open Group.
- XNS, Issue 5  
CAE Specification, February 1997, Networking Services, Issue 5 (ISBN: 1-85912-165-9, C523), published by The Open Group.
- XNS, Issue 5.2  
Technical Standard, January 2000, Networking Services (XNS), Issue 5.2 (ISBN: 1-85912-241-8, C808), published by The Open Group.
- X/Open Curses, Issue 4, Version 2  
CAE Specification, May 1996, X/Open Curses, Issue 4, Version 2 (ISBN: 1-85912-171-3, C610), published by The Open Group.
- Yacc  
*Yacc: Yet Another Compiler Compiler*, Stephen C. Johnson, 1978.

### Source Documents

Parts of the following documents were used to create the base documents for POSIX.1-2001:

- AIX 3.2 Manual  
AIX Version 3.2 For RISC System/6000, Technical Reference: Base Operating System and Extensions, 1990, 1992 (Part No. SC23-2382-00).
- OSF/1  
OSF/1 Programmer's Reference, Release 1.2 (ISBN: 0-13-020579-6).
- OSF AES  
Application Environment Specification (AES) Operating System Programming Interfaces Volume, Revision A (ISBN: 0-13-043522-8).
- System V Release 2.0  
— UNIX System V Release 2.0 Programmer's Reference Manual (April 1984 - Issue 2).  
— UNIX System V Release 2.0 Programming Guide (April 1984 - Issue 2).
- System V Release 4.2  
Operating System API Reference, UNIX<sup>®</sup> SVR4.2 (1992) (ISBN: 0-13-017658-3).

**Standard for Information Technology—  
Portable Operating System Interface (POSIX<sup>®</sup>)**

**Base Specifications, Issue 7**

Prepared by the Austin Group ([www.opengroup.org/austin](http://www.opengroup.org/austin)).

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1       **Vol. 1:**  
2       **Base Definitions, Issue 7**

3       *The Open Group*  
4       *The Institute of Electrical and Electronics Engineers, Inc.*



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## 1.1 Scope

POSIX.1-2008 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.1-2008 comprises four major components (each in an associated volume):

1. General terms, concepts, and interfaces common to all volumes of POSIX.1-2008, including utility conventions and C-language header definitions, are included in the Base Definitions volume of POSIX.1-2008.
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.1-2008.
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.1-2008.
4. Extended rationale that did not fit well into the rest of the document structure, containing historical information concerning the contents of POSIX.1-2008 and why features were included or discarded by the standard developers, is included in the Rationale (Informative) volume of POSIX.1-2008.

The following areas are outside of the scope of POSIX.1-2008:

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

POSIX.1-2008 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.1-2008 are drawn from the following base documents:

- IEEE Std 1003.1, 2004 Edition (POSIX-1) (incorporating IEEE Std 1003.1-2001, IEEE Std 1003.1-2001/Cor 1-2002, and IEEE Std 1003.1-2001/Cor 2-2004)

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