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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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USA

IEEE Std 1003.1™, 2016 Edition
(incorporates IEEE Std 1003.1-2008,
IEEE Std 1003.1-2008/Cor 1-2013,
and IEEE Std 1003.1-2008/Cor 2-2016)

IEEE Std 1003.1™, 2016 Edition

The Open Group Standard, Base Specifications, Issue 7
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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)

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Published 30 September 2016 by the IEEE.

PDF: ISBN 978-1-5044-2337-3 STD21120

Print: ISBN 978-1-5044-2338-0 STDPD21120

Published 30 September 2016 by The Open Group.

Doc. Number: C165

ISBN: 1-937218-81-2

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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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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*
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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.[A]

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.

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.

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[B], 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.

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

  No 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	**aiocb**	
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`**	

Reference	Example	Notes
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.
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 POSIX*string* (where *string* may contain underscores) is represented by the C identifier _POSIX*string*, 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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Acknowledgements

The contributions of the following organizations to the development of POSIX.1-2008 are gratefully acknowledged:

- AT&T for permission to reproduce portions of its copyrighted System V Interface Definition (SVID) and material from the UNIX System V Release 2.0 documentation
- Hewlett-Packard Company, International Business Machines Corporation, Novell Inc., The Open Software Foundation, and Sun Microsystems Inc. for permission to reproduce portions of their copyrighted documentation
- ISO/IEC JTC 1/SC 22/WG 14 C Language Committee
- Red Hat Inc. for permission to reproduce portions of its copyrighted documentation

POSIX.1-2008 was prepared by the Austin Group, a joint working group of the IEEE, The Open Group, and ISO/IEC JTC 1/SC 22.

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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

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

Chapter 1

Introduction

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)

