                Preparation of Internationalized Strings ("stringprep")

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Abstract

   This document describes a framework for preparing Unicode text
   strings in order to increase the likelihood that string input and
   string comparison work in ways that make sense for typical users
   throughout the world. The stringprep protocol is useful for protocol
   identifier values, company and personal names, internationalized
   domain names, and other text strings.

   This document does not specify how protocols should prepare text
   strings. Protocols must create profiles of stringprep in order to
   fully specify the processing options.

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1. Introduction

   Application programs can display text in many different ways.
   Similarly, a user can enter text into an application program in a
   myriad of fashions. Internationalized text (that is, text that is
   not restricted to the narrow set of US-ASCII characters) has many
   input and display behaviors that make it difficult to compare text in
   a consistent fashion.

   This document specifies a framework of processing rules for Unicode
   text. Other protocols can create profiles of these rules; these
   profiles will allow users to enter internationalized text strings in
   applications and have the highest chance of getting the content of
   the strings correct. In this case, "correct" means that if two
   different people enter what they think is the same string into two
   different input mechanisms, the strings should match on a character-
   by-character basis.

   This framework does not describe how data is transcoded from other
   character sets into Unicode. In systems that uses non-Unicode
   character sets, the transcoding algorithm is a critical part of
   enabling secure and "correct" operation of internationalized text
   strings.

   In addition to helping string matching, profiles of stringprep can
   also exclude characters that should not normally appear in text that
   is used in the protocol. The profile can prevent such characters by
   changing the characters to be excluded to other characters, by
   removing those characters, or by causing an error if the characters
   would appear in the output. For example, because the backspace
   character can cause unpredictable display results, a profile can
   specify that a string containing a backspace character would cause an
   error.

   A profile of stringprep converts a single string of input characters
   to a string of output characters, or returns an error if the output
   string would contain a prohibited character. Stringprep profiles
   cannot both emit a string and return an error.

   Stringprep profiles cannot account for all of the variations that
   might occur or that a user might expect. In particular, a profile
   will not be able to account for choice of spellings in all languages
   for all scripts because the number of alternative spellings of words
   and phrases is immense. Users would probably expect all spelling
   equivalents to be made equivalent, or none of them to be. Examples
   of spelling equivalents include "theater" vs. "theatre", and
   "hemoglobin" vs. "h<U+00E6>moglobin" in American vs. British English.
   Other examples are simplified Chinese spellings of names (for

example,"<U+7EDF><U+4E00><U+7801>") vs. the equivalent traditional
Chinese spelling (for example, "<U+7D71><U+4E00><U+78BC>").
Language-specific equivalences such as "Aepfel" vs. "<U+00C4>pfel",
which are sometimes considered equivalent in German, may not be
considered equivalent in other languages.

1.1 Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
"SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this
document are to be interpreted as described in BCP 14, RFC 2119
[RFC2119].

Note: A glossary of terms used in Unicode and ISO/IEC 10646 can be
found in [Glossary]. Information on the 10646/Unicode character
encoding model can be found in [CharModel].

Character names in this document use the notation for code points and
names from the Unicode Standard [Unicode3.2] and ISO/IEC 10646
[ISO10646]. For example, the letter "a" may be represented as either
"U+0061" or "LATIN SMALL LETTER A". In the lists of mappings and the
prohibited characters, the "U+" is left off to make the lists easier
to read. The comments for character ranges are shown in square
brackets (such as "[CONTROL CHARACTERS]") and do not come from the
standards.

1.2 Using stringprep in protocols

The stringprep protocol does not stand on its own; it has to be used
by other protocols at precisely-defined places in those other
protocols. For example, a protocol that has strings that come from
the entire ISO/IEC 10646 [ISO10646] character repertoire might
specify that only strings that have been processed with a particular
profile of stringprep are legal. Another example would be a protocol
that does string comparison as a step in the protocol; that protocol
might specify that such comparison is done only after processing the
strings with a specific profile of stringprep.

When two protocols that use different profiles of stringprep
interoperate, there may be conflict about what characters are and are
not allowed in the final string. Thus, protocol developers should
strongly consider re-using existing profiles of stringprep.

When developers wish to allow users as wide of a range of characters
as possible in input text strings, they should, where possible, cause
stringprep to convert characters from the input string to a canonical
form instead of prohibiting them.

Although it would be easy to use the stringprep process to "correct"
perceived mis-features or bugs in the current character standards,
stringprep profiles SHOULD NOT do so.

A profile of stringprep can create tables different from those in the
appendixes of this document, but it will be an exception when they
do. The intention of stringprep is to define the tables and have the
profiles of stringprep select among those defined tables.

A profile of stringprep MUST include all of the following:

- The intended applicability of the profile

- The character repertoire that is the input and output to stringprep
  (which is Unicode 3.2 for this version of stringprep)

- The mapping tables from this document used (as described in section
  3)

- Any additional mapping tables specific to the profile

- The Unicode normalization used, if any (as described in section 4)

- The tables from this document of characters that are prohibited as
  output (as described in section 5)

- The bidirectional string testing used, if any (as described in
  section 6)

- Any additional characters that are prohibited as output specific to
  the profile

Each profile MUST state the character repertoire on which the profile
will operate. Appendix A lists the Unicode repertoires that can be
selected. No repertoire is ever complete, and it is expected that
characters will be added to the Unicode repertoire for the
foreseeable future. Section 7 of this document describes how to
handle characters that are assigned in later versions of the Unicode
repertories. Subsections of appendix A also list unassigned code
points for each repertoire.

This document is for Unicode version 3.2, and should not be
considered to automatically apply to later Unicode versions. The
IETF, through an explicit standards action, may update this document
as appropriate to handle later Unicode versions.

This document lists the unassigned code points in the range 0 to
10FFFF for Unicode 3.2 in appendix A. The list in appendix A MUST be
used by implementations of this specification. If there are any
discrepancies between the list in appendix A and the Unicode 3.2
specification, the list in appendix A always takes precedence.

Each profile of stringprep MUST be registered with IANA. The
registration procedure is described in the IANA Considerations
appendix; basically, the IESG must review each profile of stringprep.
Protocol developers are strongly encouraged to look through the IANA
profile registry when creating new profiles for stringprep, and to
re-use logic from earlier profiles where possible in new profiles.
In some cases, an existing profile can be reused by a different
protocol.

2. Preparation Overview

The steps for preparing strings are:

1) Map -- For each character in the input, check if it has a mapping
   and, if so, replace it with its mapping. This is described in
   section 3.

2) Normalize -- Possibly normalize the result of step 1 using Unicode
   normalization. This is described in section 4.

3) Prohibit -- Check for any characters that are not allowed in the
   output. If any are found, return an error. This is described in
   section 5.

4) Check bidi -- Possibly check for right-to-left characters, and if
   any are found, make sure that the whole string satisfies the
   requirements for bidirectional strings. If the string does not
   satisfy the requirements for bidirectional strings, return an
   error. This is described in section 6.

The above steps MUST be performed in the order given to comply with
this specification.

The mappings described in section 3, and the optional Unicode
normalization described in section 4, can be one-to-none, one-to-one,
one-to-many, many-to-one, or many-to-many. That is, some characters
might be eliminated or replaced by more than one character, and the
output of this step might be shorter or longer than the input.
Because of this, the system using stringprep MUST be prepared to
receive a longer or shorter string than the one input in the
stringprep algorithm.

3. Mapping

   Each character in the input stream MUST be checked against a mapping
   table. The mapping table SHOULD come from this document, although
   the mapping table MAY be added to or altered by the profile. The
   mapping tables are subsections of appendix B.

   The lists in appendix B MUST be used by implementations of this
   specification. If there are any discrepancies between the lists in
   appendix B and subsections below, the lists in appendix B always
   takes precedence.

   For any individual character, the mapping table MAY specify that a
   character be mapped to nothing, or mapped to one other character, or
   mapped to a string of other characters.

   Mapped characters are not re-scanned during the mapping step. That
   is, if character A at position X is mapped to character B, character
   B which is now at position X is not checked against the mapping
   table.

3.1 Commonly mapped to nothing

   The following characters are simply deleted from the input (that is,
   they are mapped to nothing) because their presence or absence in
   protocol identifiers should not make two strings different. They are
   listed in Table B.1.

   Some characters are only useful in line-based text, and are otherwise
   invisible and ignored.

   00AD; SOFT HYPHEN
   1806; MONGOLIAN TODO SOFT HYPHEN
   200B; ZERO WIDTH SPACE
   2060; WORD JOINER
   FEFF; ZERO WIDTH NO-BREAK SPACE

   Some characters affect glyph choice and glyph placement, but do not
   bear semantics.

   034F; COMBINING GRAPHEME JOINER
   180B; MONGOLIAN FREE VARIATION SELECTOR ONE
   180C; MONGOLIAN FREE VARIATION SELECTOR TWO
   180D; MONGOLIAN FREE VARIATION SELECTOR THREE
   200C; ZERO WIDTH NON-JOINER
   200D; ZERO WIDTH JOINER
   FE00; VARIATION SELECTOR-1
   FE01; VARIATION SELECTOR-2

```
    FE02; VARIATION SELECTOR-3
    FE03; VARIATION SELECTOR-4
    FE04; VARIATION SELECTOR-5
    FE05; VARIATION SELECTOR-6
    FE06; VARIATION SELECTOR-7
    FE07; VARIATION SELECTOR-8
    FE08; VARIATION SELECTOR-9
    FE09; VARIATION SELECTOR-10
    FE0A; VARIATION SELECTOR-11
    FE0B; VARIATION SELECTOR-12
    FE0C; VARIATION SELECTOR-13
    FE0D; VARIATION SELECTOR-14
    FE0E; VARIATION SELECTOR-15
    FE0F; VARIATION SELECTOR-16
```

3.2 Case folding

   If a profile is going to map characters for case-insensitive
   comparison, that profile SHOULD map using either appendix B.2 or
   appendix B.3. appendix B.2 is for profiles that also use Unicode
   normalization form KC, while appendix B.3 is for profiles that do
   not use Unicode normalization. These tables map from uppercase to
   lowercase characters. Note that this could have been "change all
   lowercase characters into uppercase characters". However, the
   upper-to-lower folding was chosen because there is a tradition of
   using lowercase in current Internet applications and protocols.

   If a profile creates its own mapping tables for case folding, they
   SHOULD be based on [UTR21], and SHOULD map from uppercase characters
   to lowercase. The "CaseFolding.txt" file from the Unicode database
   SHOULD be used to prepare the mapping table. The profile SHOULD do
   full case mapping (that is, using statuses C, F, and I).

   If the profile is using Unicode normalization form KC (as described
   in section 4 of this document), it is important to note that there
   are some characters that do not have mappings in [UTR21] but still
   need processing. These characters include a few Greek characters and
   many symbols that contain Latin characters. The list of characters
   to add to the mapping table can determined by the following
   algorithm:

   b = NormalizeWithKC(Fold(a));
   c = NormalizeWithKC(Fold(b));
   if c is not the same as b, add a mapping for "a to c".

   Because NormalizeWithKC(Fold(c)) always equals c, the table is stable
   from that point on.

Appendix B.3 is derived from the CaseFolding-3.txt file associated
with Unicode 3.2; appendix B.2 is based on appendix B.3 with the
additional characters added from the algorithm above.

Authors of profiles of this document need to consider the effects of
changing the mapping of any currently-assigned character when
updating their profiles. Adding a new mapping for a currently-
assigned character, or changing an existing mapping, could cause a
variance between the behavior of systems that have been updated and
systems that have not been updated.

4. Normalization

The output of the mapping step is optionally normalized using one of
the Unicode normalization forms, as described in [UAX15]. A profile
can specify one of two options for Unicode normalization:

- no normalization

- Unicode normalization with form KC

A profile MAY choose to do no normalization. However, such a profile
can easily yield results that will be surprising to typical users,
depending on the input mechanism they use. For example, some input
mechanisms enter compatibility characters that look exactly like the
underlying characters, but have different code points. Another
example of where Unicode normalization helps create predictable
results is with characters that have multiple combining diacritics:
normalization orders those diacritics in a predictable fashion.

On the other hand, Unicode normalization requires fairly large tables
and somewhat complicated character reordering logic. The size and
complexity should not be considered daunting except in the most
restricted of environments, and needs to be weighed against the
problems of user surprise from comparing unnormalized strings. Note
that the tables used for normalization are not given in this
document, but instead must be derived from the Unicode database, as
described in [UAX15].

There is a third form of normalization, Unicode normalization with
form C. If a profile is going to use a Unicode normalization, it
MUST use Unicode normalization form KC. Form KC maps many
"compatibility characters" to their equivalents. Some user interface
systems make it possible to enter compatibility characters instead of
the base equivalents. Thus, using form KC instead of form C will
cause more strings that users would expect to match to actually
match.

A profile that specifies Unicode normalization MUST use the
normalization in [UAX15] that is associated with the version of the
Unicode character set specified for the profile.

The composition process described in [UAX15] requires a fixed
composition version of Unicode to ensure that strings normalized
under one version of Unicode remain normalized under all future
versions of Unicode.

The IETF is relying on Unicode not to change the normalization of
currently-assigned characters in future versions of normalization.
If a future version of the normalization tables changes the
normalized value of an existing character, authors of profiles of
this document have to look at the changes very carefully before they
update their normalization tables. Such a change could cause a
variance between the behavior of systems that have been updated and
systems that have not been updated.

5. Prohibited Output

Before the text can be emitted, it MUST be checked for prohibited
code points. There are a variety of prohibited code points, as
described in this section. A profile of this document MAY use all or
some of the tables in appendix C.

The stringprep process never emits both an error and a string. If an
error is detected during the checking for prohibited code points,
only an error is returned.

Note that the subsections below describe how the tables in appendix C
were formed. They are here for people who want to understand more,
but they should be ignored by implementors. Implementations that use
tables MUST map based on the tables themselves, not based on the
descriptions in this section of how the tables were created.

The lists in appendix C MUST be used by implementations of this
specification. If there are any discrepancies between the lists in
appendix C and subsections below, the lists in appendix C always take
precedence.

Some code points listed in one section may also appear in other
sections.

It is important to note that a profile of this document MAY prohibit
additional characters.

Each subsection of this section has a matching subsection in appendix
C. For example, the characters listed in section 5.1 are listed in
appendix C.1.

5.1 Space characters

Space characters can make accurate visual transcription of strings
nearly impossible and could lead to user entry errors in many ways.
Note that the list below is split into two tables in appendix C:
Table C.1.1 contains the ASCII code points, while Table C.1.2
contains the non-ASCII code points. Most profiles of this document
that want to prohibit space characters will want to include both
tables.

```
0020; SPACE
00A0; NO-BREAK SPACE
1680; OGHAM SPACE MARK
2000; EN QUAD
2001; EM QUAD
2002; EN SPACE
2003; EM SPACE
2004; THREE-PER-EM SPACE
2005; FOUR-PER-EM SPACE
2006; SIX-PER-EM SPACE
2007; FIGURE SPACE
2008; PUNCTUATION SPACE
2009; THIN SPACE
200A; HAIR SPACE
200B; ZERO WIDTH SPACE
202F; NARROW NO-BREAK SPACE
205F; MEDIUM MATHEMATICAL SPACE
3000; IDEOGRAPHIC SPACE
```

5.2 Control characters

Control characters (or characters with control function) cannot be
seen and can cause unpredictable results when displayed. Note that
the list below is split into two tables in appendix C: Table C.2.1
contains the ASCII code points, while Table C.2.2 contains the non-
ASCII code points. Most profiles of this document that want to
prohibit control characters will want to include both tables.

```
0000-001F; [CONTROL CHARACTERS]
007F; DELETE
0080-009F; [CONTROL CHARACTERS]
06DD; ARABIC END OF AYAH
070F; SYRIAC ABBREVIATION MARK
180E; MONGOLIAN VOWEL SEPARATOR
```

```
200C; ZERO WIDTH NON-JOINER
200D; ZERO WIDTH JOINER
2028; LINE SEPARATOR
2029; PARAGRAPH SEPARATOR
2060; WORD JOINER
2061; FUNCTION APPLICATION
2062; INVISIBLE TIMES
2063; INVISIBLE SEPARATOR
206A-206F; [CONTROL CHARACTERS]
FEFF; ZERO WIDTH NO-BREAK SPACE
FFF9-FFFC; [CONTROL CHARACTERS]
1D173-1D17A; [MUSICAL CONTROL CHARACTERS]
```

5.3 Private use

Because private-use characters do not have defined meanings, they are
likely to be prohibited. The private-use characters are:

```
E000-F8FF; [PRIVATE USE, PLANE 0]
F0000-FFFFD; [PRIVATE USE, PLANE 15]
100000-10FFFD; [PRIVATE USE, PLANE 16]
```

5.4 Non-character code points

Non-character code points are code points that have been allocated in
ISO/IEC 10646 but are not characters. Because they are already
assigned, they are guaranteed not to later change into characters.

```
FDD0-FDEF; [NONCHARACTER CODE POINTS]
FFFE-FFFF; [NONCHARACTER CODE POINTS]
1FFFE-1FFFF; [NONCHARACTER CODE POINTS]
2FFFE-2FFFF; [NONCHARACTER CODE POINTS]
3FFFE-3FFFF; [NONCHARACTER CODE POINTS]
4FFFE-4FFFF; [NONCHARACTER CODE POINTS]
5FFFE-5FFFF; [NONCHARACTER CODE POINTS]
6FFFE-6FFFF; [NONCHARACTER CODE POINTS]
7FFFE-7FFFF; [NONCHARACTER CODE POINTS]
8FFFE-8FFFF; [NONCHARACTER CODE POINTS]
9FFFE-9FFFF; [NONCHARACTER CODE POINTS]
AFFFE-AFFFF; [NONCHARACTER CODE POINTS]
BFFFE-BFFFF; [NONCHARACTER CODE POINTS]
CFFFE-CFFFF; [NONCHARACTER CODE POINTS]
DFFFE-DFFFF; [NONCHARACTER CODE POINTS]
EFFFE-EFFFF; [NONCHARACTER CODE POINTS]
FFFFE-FFFFF; [NONCHARACTER CODE POINTS]
10FFFE-10FFFF; [NONCHARACTER CODE POINTS]
```

The non-character code points are listed in the PropList.txt file
from the Unicode database.

5.5 Surrogate codes

The following code points are permanently reserved for use as
surrogate code values in the UTF-16 encoding, will never be assigned
to characters in the Unicode repertoire, and are therefore
prohibited:

D800-DFFF; [SURROGATE CODES]

5.6 Inappropriate for plain text

The following characters do not appear in regular text.

FFF9; INTERLINEAR ANNOTATION ANCHOR
FFFA; INTERLINEAR ANNOTATION SEPARATOR
FFFB; INTERLINEAR ANNOTATION TERMINATOR
FFFC; OBJECT REPLACEMENT CHARACTER

Although the replacement character (U+FFFD) might be used when a
string is displayed, it doesn't make sense for it to be part of the
string itself. It is often displayed by renderers to indicate "there
would be some character here, but it cannot be rendered". For
example, on a computer with no Asian fonts, a string with three
ideographs might be rendered with three replacement characters.

FFFD; REPLACEMENT CHARACTER

5.7 Inappropriate for canonical representation

The ideographic description characters allow different sequences of
characters to be rendered the same way, which makes them
inappropriate for strings that have to have a single canonical
representation.

2FF0-2FFB; [IDEOGRAPHIC DESCRIPTION CHARACTERS]

5.8 Change display properties or are deprecated

The following characters can cause changes in display or the order in
which characters appear when rendered, or are deprecated in Unicode.

0340; COMBINING GRAVE TONE MARK
0341; COMBINING ACUTE TONE MARK
200E; LEFT-TO-RIGHT MARK
200F; RIGHT-TO-LEFT MARK

       202A; LEFT-TO-RIGHT EMBEDDING
       202B; RIGHT-TO-LEFT EMBEDDING
       202C; POP DIRECTIONAL FORMATTING
       202D; LEFT-TO-RIGHT OVERRIDE
       202E; RIGHT-TO-LEFT OVERRIDE
       206A; INHIBIT SYMMETRIC SWAPPING
       206B; ACTIVATE SYMMETRIC SWAPPING
       206C; INHIBIT ARABIC FORM SHAPING
       206D; ACTIVATE ARABIC FORM SHAPING
       206E; NATIONAL DIGIT SHAPES
       206F; NOMINAL DIGIT SHAPES

5.9 Tagging characters

   The following characters are used for tagging text and are invisible.

       E0001; LANGUAGE TAG
       E0020-E007F; [TAGGING CHARACTERS]

6. Bidirectional Characters

   Most characters are displayed from left to right, but some are
   displayed from right to left. This feature of Unicode is called
   "bidirectional text", or "bidi" for short. The Unicode standard has
   an extensive discussion of how to reorder glyphs for display when
   dealing with bidirectional text such as Arabic or Hebrew. See [UAX9]
   for more information. In particular, all Unicode text is stored in
   logical order.

   A profile MAY choose to ignore bidirectional text. However, ignoring
   bidirectional text can cause display ambiguities. For example, it is
   quite easy to create two different strings with the same characters
   (but in different order) that are correctly displayed identically.
   Therefore, in order to avoid most problems with ambiguous
   bidirectional text display, profile creators should strongly consider
   including the bidirectional character handling described in this
   section in their profile.

   The stringprep process never emits both an error and a string. If an
   error is detected during the checking of bidirectional strings, only
   an error is returned.

   [Unicode3.2] defines several bidirectional categories; each character
   has one bidirectional category assigned to it. For the purposes of
   the requirements below, an "RandALCat character" is a character that
   has Unicode bidirectional categories "R" or "AL"; an "LCat character"
   is a character that has Unicode bidirectional category "L". Note

that there are many characters which fall in neither of the above
definitions; Latin digits (<U+0030> through <U+0039>) are examples of
this because they have bidirectional category "EN".

In any profile that specifies bidirectional character handling, all
three of the following requirements MUST be met:

1) The characters in section 5.8 MUST be prohibited.

2) If a string contains any RandALCat character, the string MUST NOT
   contain any LCat character.

3) If a string contains any RandALCat character, a RandALCat
   character MUST be the first character of the string, and a
   RandALCat character MUST be the last character of the string.

Note that requirement 3 prohibits strings such as <U+0627><U+0031>
("aleph 1") but allows strings such as <U+0627><U+0031><U+0628>
("aleph 1 beh"). [UAX9] goes into great detail about the display
order of strings that contain particular categories of characters in
particular sequences.

Table D.1 lists the characters that belong to Unicode bidirectional
categories "R" and "AL". Table D.2 lists all the characters that
belong to Unicode bidirectonal category "L". These tables are
derived from [Unicode3.2].

7. Unassigned Code Points in Stringprep Profiles

This section describes two different types of strings in typical
protocols where internationalized strings are used: "stored strings"
and "queries". Of course, different Internet protocols use strings
very differently, so these terms cannot be used exactly in every
protocol that needs to use stringprep. In general, "stored strings"
are strings that are used in protocol identifiers and named entities,
such as names in digital certificates and DNS domain name parts.
"Queries" are strings that are used to match against strings that are
stored identifiers, such as user-entered names for digital
certificate authorities and DNS lookups.

All code points not assigned in the character repertoire named in a
stringprep profile are called "unassigned code points". Stored
strings using the profile MUST NOT contain any unassigned code
points. Queries for matching strings MAY contain unassigned code
points. Note that this is the only part of this document where the
requirements for queries differs from the requirements for stored
strings.

   Using two different policies for where unassigned code points can
   appear removes the need for versioning in protocols that use
   stringprep profiles. This is very useful since it makes the overall
   processing simpler and does not impose a "protocol" to handle
   versioning. It is expected that the ISO/IEC 10646 and Unicode
   repertoires will be updated fairly frequently; at the time that this
   document is being written, it has happened approximately once a year.
   Each time a new version of a repertoire appears, a new version of a
   profile MAY be created. Some end users will want to use the new code
   points as soon as they are defined.

   The list of unassigned code points MUST be given in a profile, and
   that list MUST be used by implementations of the profile.

   The goal of the requirements in this section is to prevent
   comparisons between two strings that were both permitted to contain
   unassigned code points. When two strings X and Y are compared and
   string Y was prepared in a way that permits unassigned code points, a
   negative result to the comparison is not definitive; it's possible
   that the strings don't match even though they would match if a more
   recent version of the profile were used for Y. However, if both X
   and Y were prepared in a way that permits unassigned code points,
   something worse can happen: even a positive result for the comparison
   is not definitive. It is possible that the strings do match even
   though they would not match if a more recent version of the profile
   were used (one that prohibits a code point appearing in both X and
   Y).

   Due to the way that versioning is handled in this section, stored
   strings that are embedded in structures that cannot be changed (such
   as the signed parts of digital certificates) MUST NOT contain any
   unassigned code points.

7.1 Categories of code points

   Each code point in a repertoire named by a profile of stringprep can
   be categorized by how it acts in the process described in earlier
   sections of this document:

      AO   Code points that can be in the output

      MN   Code points that cannot be in the output because they
               never appear as output from mapping or normalization

      D   Code points that cannot be in the output because they are
               disallowed in the prohibition step

      U   Unassigned code points

A subsequent version of a profile that references a newer version of
a repertoire with new code points will inherently have some code
points move from category U to either D, MN, or AO. For backwards
compatibility, a subsequent version of a profile MUST NOT move code
points from any other category. That is, current AO, MN, or D code
points MUST NOT ever change to a different category.

Stored strings MUST NOT contain any code points outside of AO for the
latest version of a profile. That is, they are forbidden to contain
code points from the MN, D, or U categories.

Applications creating queries MUST treat U code points as if they
were AO when preparing the query to be entered in the process
described by a profile of stringprep. Those applications MAY
optionally have a preprocessor that provide stricter checks: treating
unassigned code points in the input as errors, or warning the user
about the fact that the code point is unassigned in the version of a
profile that the software is based on; such a choice is a local
matter for the software.

7.2 Reasons for the difference between stored strings and queries

Different software using different versions of a stringprep profile
need to interoperate with maximal compatibility. The scheme
described in this section (stored strings MUST NOT contain unassigned
code points, queries MAY include unassigned code points) allows that
compatibility without introducing any known security or
interoperability issues.

The list below shows what happens if a query contains a code point
from category U that is allowed in a newer version of a profile. The
query either matches the string that was intended, or matches no
string at all. In this list, the query comes from an application
using version "oldVersion" of a profile, the stored string was
created using version "newVersion" of the same profile, and the code
point X was in category U in oldVersion, and has changed category to
AO, MN, or D. There are 3 possible scenarios:

1. X is assigned to AO -- In newVersion, X is in category AO.
   Because the application passed X through, it gets back a positive
   match with the stored string. There is one exceptional case,
   where X is a combining mark.

   The order of combining marks is normalized, so if another
   combining mark Y has a lower combining class than X then XY will
   be put in the canonical order YX. (Unassigned code points are
   never reordered, so this doesn't happen in oldVersion). If the
   query contains YX, the query will get positive match with the

stored string. However, no string can be stored with XY, so a
query with XY will get a negative answer to the test for matching.

2. X is assigned to MN -- In newVersion, X is normalized to code
   point "nX" and therefore X is now put in category MN. This cannot
   exist in any stored string, so any query containing X will get a
   negative answer to the test for matching. Note, however, if the
   query had contained the letter nX, it would have positively
   matched.

3. X is assigned to D -- In newVersion, X is in category D. This
   cannot exist in any stored string, so any query containing X will
   get a negative answer to the test for matching.

In none of the cases does the query get data for a stored string
other than the one it actually tried to match against.

Profiles are stable between versions in the following sense: If a
string S has been prepared using newVersion, then it will not change
if it is subsequently prepared using oldVersion.

7.3 Versions of applications and stored strings

Another way to see that this versioning system works is to compare
what happens when an application uses a newer or older version of a
profile.

Newer query application -- Suppose that a querying application is
using version newVersion and the stored string was created using
version oldVersion. This case is simple: there will be no characters
in the stored string that cannot be queried by the application
because the new profile uses a superset of the code points used for
making the stored string.

Newer stored string -- Suppose that a querying application is using
oldVersion and the stored string was created using a profile that
uses newVersion. Because the querying application let unassigned
code points pass through, the user can query on stored strings that
use code points in newVersion. No stored strings can have code
points that are unassigned in newVersion, since that is illegal. In
order to get a match, the querying application has to enter the
unassigned code points in the proper order, and has to use unassigned
code points that would make it through both the mapping and the
normalization steps.

8. References

8.1 Normative references

    [UAX15]   Mark Davis and Martin Duerst. Unicode Standard Annex
                   #15: Unicode Normalization Forms, Version 3.2.0.
                   <http://www.unicode.org/unicode/reports/tr15/tr15-
                   22.html>.

    [Unicode3.2]   The Unicode Consortium. The Unicode Standard, Version
                   3.2.0 is defined by The Unicode Standard, Version 3.0
                   (Reading, MA, Addison-Wesley, 2000. ISBN 0-201-61633-5),
                   as amended by the Unicode Standard Annex #27: Unicode
                   3.1 (http://www.unicode.org/reports/tr27/) and by the
                   Unicode Standard Annex #28: Unicode 3.2
                   (http://www.unicode.org/reports/tr28/).

    [RFC2119]   Bradner, S., "Key words for use in RFCs to Indicate
                   Requirement Levels", BCP 14, RFC 2119, March 1997.

8.2 Informative references

    [CharModel]   Unicode Technical Report;17, Character Encoding Model.
                   <http://www.unicode.org/unicode/reports/tr17/>.

    [Glossary]   Unicode Glossary, <http://www.unicode.org/glossary/>.

    [ISO10646]   ISO/IEC, "Information Technology - Universal Multiple-
                   Octet Coded Character Set (UCS) - Part 1: Architecture
                   and Basic Multilingual Plane", ISO/IEC 10646-1:2000,
                   October 2000.

    [RFC2434]   Narten, T. and H. Alvestrand, "Guidelines for IANA
                   Considerations", BCP 26, RFC 2434, October 1998.

    [UAX9]   The Unicode Consortium. Unicode Standard Annex #9, The
                   Bidirectional Algorithm,
                   <http://www.unicode.org/unicode/reports/tr9/>.

    [UTR21]   Mark Davis. Case Mappings. Unicode Technical Report 21.
                   <http://www.unicode.org/unicode/reports/tr21/>.

9. Security Considerations

    Stringprep is used with Unicode characters. There are security
    considerations that are specific to stringprep, and others that are
    generic to using Unicode.

9.1 Stringprep-specific security considerations

   The Unicode and ISO/IEC 10646 repertoires have many characters that
   look similar. In many cases, users of security protocols might do
   visual matching, such as when comparing the names of trusted third
   parties. Because it is impossible to map similar-looking characters
   without a great deal of context such as knowing the fonts used,
   stringprep does nothing to map similar-looking characters together
   nor to prohibit some characters because they look like others. User
   applications can help disambiguate some similar-looking characters by
   showing the user when a string changes between scripts.

   Most profiles of stringprep can cause changes in strings that are
   input to stringprep. Because of this, protocols that have sets of
   non-allowed characters or sequences MUST check for the non-allowed
   characters or sequences after the stringprep processing.

   This document does not mandate the checking of bidirectional
   characters in section 6. If the requirements in section 6 are not
   used in a profile of stringprep, it is easy to create many strings
   whose characters are in different order but are displayed
   identically. This can cause security-related user confusion similar
   to look-alike characters, as described above.

   Stringprep does not do anything to assure that any algorithms
   translating characters from non-Unicode into Unicode produce the same
   output in all implementations.

   Some Unicode codepoints are invisible. Protocols that allow these
   characters (that is, do not map them out or prohibit them in
   stringprep) can cause users confusion when two identical-looking
   strings do not match.

9.2 Generic Unicode security considerations

   Using Unicode characters explicitly forces applications to use
   multi-octet characters. Converting an application from one that uses
   single-octet characters to one that uses multi-octet characters must
   be done very carefully, particularly in an application that checks
   for values of characters or sorts characters.

   Protocols that use stringprep usually also use encodings of Unicode,
   such as UTF-8 or UTF-16. Some applications using those encodings
   have been known to not check for illegal or ill-formed sequences in
   the encodings, and thereby have not detected sequences of octets that
   would have been detected if they used just ASCII. For example, in

UTF-8 the octet sequence "0xC0 0xAB" is an illegal formation of
U+002B (plus sign). All programs should reject any string that is an
illegal or ill-formed octet sequence for the encoding being used.

Both Unicode normalization and conversion between Unicode encodings
can cause strings to grow or shrink. Programs that used fixed-size
buffers, or that make assumptions that buffers will always be greater
than or less than particular sizes, are likely to fail in insecure
fashions when using Unicode normalization or encoding conversions.

Covering an extensive list of security threats and considerations on
the use of current and future versions of Unicode is outside of the
scope of this document.

10. IANA Considerations

Stringprep profiles MUST have IETF consensus as described in
[RFC2434]. Each profile MUST be reviewed by the IESG before it is
registered. The IESG MAY change a profile before registration.

IANA has set up a registry of stringprep profiles. This registry is
a single text file that lists the known profiles. Each entry in the
registry has three fields:

- Profile name

- RFC in which the profile is defined

- Indicator whether or not this is the newest version of the profile

Each version of a profile will remain listed in the registry forever.
That is, if a new version of a profile supersedes an earlier version,
both versions will continue to be listed in the registry, but the
current version indicator will be turned off for the earlier version
and turned on for the newer version.

It is probably harmful if a large number of profiles of stringprep
proliferate. Therefore, the IESG may reject proposals for new
profiles and instead suggest that protocols reuse existing profiles.

11. Acknowledgements

   Many people from the IETF IDN Working Group and the Unicode Technical
   Committee contributed ideas that went into the first document of this
   document. Mark Davis and Patrik Faltstrom were particularly helpful
   in some of the ideas, such as the versioning description.

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   Cathy Wissink
   Francois Yergeau
   James Seng
   Marc Blanchet
   Mark Davis
   Martin Duerst
   Patrik Faltstrom
   Paul Hoffman

   Additional significant improvements were proposed by:

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   Kent Karlsson
   Scott Hollenbeck
   Dave Crocker
   Erik Nordmark
   Matitiahu Allouche

A. Unicode repertoires

   The following is the only repertoire covered in this document:

   Unicode 3.2, as defined in [Unicode3.2].

A.1 Unassigned code points in Unicode 3.2

   ----- Start Table A.1 -----
   0221
   0234-024F
   02AE-02AF
   02EF-02FF
   0350-035F
   0370-0373
   0376-0379
   037B-037D
   037F-0383
   038B
   038D
   03A2
   03CF
   03F7-03FF
   0487
   04CF
   04F6-04F7
   04FA-04FF
   0510-0530
   0557-0558
   0560
   0588
   058B-0590
   05A2
   05BA
   05C5-05CF
   05EB-05EF
   05F5-060B
   060D-061A
   061C-061E
   0620
   063B-063F
   0656-065F
   06EE-06EF
   06FF
   070E
   072D-072F
   074B-077F
   07B2-0900

    0904
    093A-093B
    094E-094F
    0955-0957
    0971-0980
    0984
    098D-098E
    0991-0992
    09A9
    09B1
    09B3-09B5
    09BA-09BB
    09BD
    09C5-09C6
    09C9-09CA
    09CE-09D6
    09D8-09DB
    09DE
    09E4-09E5
    09FB-0A01
    0A03-0A04
    0A0B-0A0E
    0A11-0A12
    0A29
    0A31
    0A34
    0A37
    0A3A-0A3B
    0A3D
    0A43-0A46
    0A49-0A4A
    0A4E-0A58
    0A5D
    0A5F-0A65
    0A75-0A80
    0A84
    0A8C
    0A8E
    0A92
    0AA9
    0AB1
    0AB4
    0ABA-0ABB
    0AC6
    0ACA
    0ACE-0ACF
    0AD1-0ADF
    0AE1-0AE5

```
0AF0-0B00
0B04
0B0D-0B0E
0B11-0B12
0B29
0B31
0B34-0B35
0B3A-0B3B
0B44-0B46
0B49-0B4A
0B4E-0B55
0B58-0B5B
0B5E
0B62-0B65
0B71-0B81
0B84
0B8B-0B8D
0B91
0B96-0B98
0B9B
0B9D
0BA0-0BA2
0BA5-0BA7
0BAB-0BAD
0BB6
0BBA-0BBD
0BC3-0BC5
0BC9
0BCE-0BD6
0BD8-0BE6
0BF3-0C00
0C04
0C0D
0C11
0C29
0C34
0C3A-0C3D
0C45
0C49
0C4E-0C54
0C57-0C5F
0C62-0C65
0C70-0C81
0C84
0C8D
0C91
0CA9
0CB4
```

```
0CBA-0CBD
0CC5
0CC9
0CCE-0CD4
0CD7-0CDD
0CDF
0CE2-0CE5
0CF0-0D01
0D04
0D0D
0D11
0D29
0D3A-0D3D
0D44-0D45
0D49
0D4E-0D56
0D58-0D5F
0D62-0D65
0D70-0D81
0D84
0D97-0D99
0DB2
0DBC
0DBE-0DBF
0DC7-0DC9
0DCB-0DCE
0DD5
0DD7
0DE0-0DF1
0DF5-0E00
0E3B-0E3E
0E5C-0E80
0E83
0E85-0E86
0E89
0E8B-0E8C
0E8E-0E93
0E98
0EA0
0EA4
0EA6
0EA8-0EA9
0EAC
0EBA
0EBE-0EBF
0EC5
0EC7
0ECE-0ECF
```

```
0EDA-0EDB
0EDE-0EFF
0F48
0F6B-0F70
0F8C-0F8F
0F98
0FBD
0FCD-0FCE
0FD0-0FFF
1022
1028
102B
1033-1035
103A-103F
105A-109F
10C6-10CF
10F9-10FA
10FC-10FF
115A-115E
11A3-11A7
11FA-11FF
1207
1247
1249
124E-124F
1257
1259
125E-125F
1287
1289
128E-128F
12AF
12B1
12B6-12B7
12BF
12C1
12C6-12C7
12CF
12D7
12EF
130F
1311
1316-1317
131F
1347
135B-1360
137D-139F
13F5-1400
```

```
   1677-167F
   169D-169F
   16F1-16FF
   170D
   1715-171F
   1737-173F
   1754-175F
   176D
   1771
   1774-177F
   17DD-17DF
   17EA-17FF
   180F
   181A-181F
   1878-187F
   18AA-1DFF
   1E9C-1E9F
   1EFA-1EFF
   1F16-1F17
   1F1E-1F1F
   1F46-1F47
   1F4E-1F4F
   1F58
   1F5A
   1F5C
   1F5E
   1F7E-1F7F
   1FB5
   1FC5
   1FD4-1FD5
   1FDC
   1FF0-1FF1
   1FF5
   1FFF
   2053-2056
   2058-205E
   2064-2069
   2072-2073
   208F-209F
   20B2-20CF
   20EB-20FF
   213B-213C
   214C-2152
   2184-218F
   23CF-23FF
   2427-243F
   244B-245F
   24FF
```

```
2614-2615
2618
267E-267F
268A-2700
2705
270A-270B
2728
274C
274E
2753-2755
2757
275F-2760
2795-2797
27B0
27BF-27CF
27EC-27EF
2B00-2E7F
2E9A
2EF4-2EFF
2FD6-2FEF
2FFC-2FFF
3040
3097-3098
3100-3104
312D-3130
318F
31B8-31EF
321D-321F
3244-3250
327C-327E
32CC-32CF
32FF
3377-337A
33DE-33DF
33FF
4DB6-4DFF
9FA6-9FFF
A48D-A48F
A4C7-ABFF
D7A4-D7FF
FA2E-FA2F
FA6B-FAFF
FB07-FB12
FB18-FB1C
FB37
FB3D
FB3F
FB42
```

```
   FB45
   FBB2-FBD2
   FD40-FD4F
   FD90-FD91
   FDC8-FDCF
   FDFD-FDFF
   FE10-FE1F
   FE24-FE2F
   FE47-FE48
   FE53
   FE67
   FE6C-FE6F
   FE75
   FEFD-FEFE
   FF00
   FFBF-FFC1
   FFC8-FFC9
   FFD0-FFD1
   FFD8-FFD9
   FFDD-FFDF
   FFE7
   FFEF-FFF8
   10000-102FF
   1031F
   10324-1032F
   1034B-103FF
   10426-10427
   1044E-1CFFF
   1D0F6-1D0FF
   1D127-1D129
   1D1DE-1D3FF
   1D455
   1D49D
   1D4A0-1D4A1
   1D4A3-1D4A4
   1D4A7-1D4A8
   1D4AD
   1D4BA
   1D4BC
   1D4C1
   1D4C4
   1D506
   1D50B-1D50C
   1D515
   1D51D
   1D53A
   1D53F
   1D545
```

```
   1D547-1D549
   1D551
   1D6A4-1D6A7
   1D7CA-1D7CD
   1D800-1FFFD
   2A6D7-2F7FF
   2FA1E-2FFFD
   30000-3FFFD
   40000-4FFFD
   50000-5FFFD
   60000-6FFFD
   70000-7FFFD
   80000-8FFFD
   90000-9FFFD
   A0000-AFFFD
   B0000-BFFFD
   C0000-CFFFD
   D0000-DFFFD
   E0000
   E0002-E001F
   E0080-EFFFD
   ----- End Table A.1 -----
```

B. Mapping Tables

   The following is the mapping table from section 3. The table has
   three columns:

   - the code point that is mapped from
   - the zero or more code points that it is mapped to
   - the reason for the mapping

   The columns are separated by semicolons. Note that the second column
   may be empty, or it may have one code point, or it may have more than
   one code point, with each code point separated by a space.

B.1 Commonly mapped to nothing

```
   ----- Start Table B.1 -----
   00AD; ; Map to nothing
   034F; ; Map to nothing
   1806; ; Map to nothing
   180B; ; Map to nothing
   180C; ; Map to nothing
   180D; ; Map to nothing
   200B; ; Map to nothing
   200C; ; Map to nothing
   200D; ; Map to nothing
```

```
    2060; ; Map to nothing
    FE00; ; Map to nothing
    FE01; ; Map to nothing
    FE02; ; Map to nothing
    FE03; ; Map to nothing
    FE04; ; Map to nothing
    FE05; ; Map to nothing
    FE06; ; Map to nothing
    FE07; ; Map to nothing
    FE08; ; Map to nothing
    FE09; ; Map to nothing
    FE0A; ; Map to nothing
    FE0B; ; Map to nothing
    FE0C; ; Map to nothing
    FE0D; ; Map to nothing
    FE0E; ; Map to nothing
    FE0F; ; Map to nothing
    FEFF; ; Map to nothing
    ----- End Table B.1 -----
```

B.2 Mapping for case-folding used with NFKC

```
    ----- Start Table B.2 -----
    0041; 0061; Case map
    0042; 0062; Case map
    0043; 0063; Case map
    0044; 0064; Case map
    0045; 0065; Case map
    0046; 0066; Case map
    0047; 0067; Case map
    0048; 0068; Case map
    0049; 0069; Case map
    004A; 006A; Case map
    004B; 006B; Case map
    004C; 006C; Case map
    004D; 006D; Case map
    004E; 006E; Case map
    004F; 006F; Case map
    0050; 0070; Case map
    0051; 0071; Case map
    0052; 0072; Case map
    0053; 0073; Case map
    0054; 0074; Case map
    0055; 0075; Case map
    0056; 0076; Case map
    0057; 0077; Case map
    0058; 0078; Case map
    0059; 0079; Case map
```

```
005A; 007A; Case map
00B5; 03BC; Case map
00C0; 00E0; Case map
00C1; 00E1; Case map
00C2; 00E2; Case map
00C3; 00E3; Case map
00C4; 00E4; Case map
00C5; 00E5; Case map
00C6; 00E6; Case map
00C7; 00E7; Case map
00C8; 00E8; Case map
00C9; 00E9; Case map
00CA; 00EA; Case map
00CB; 00EB; Case map
00CC; 00EC; Case map
00CD; 00ED; Case map
00CE; 00EE; Case map
00CF; 00EF; Case map
00D0; 00F0; Case map
00D1; 00F1; Case map
00D2; 00F2; Case map
00D3; 00F3; Case map
00D4; 00F4; Case map
00D5; 00F5; Case map
00D6; 00F6; Case map
00D8; 00F8; Case map
00D9; 00F9; Case map
00DA; 00FA; Case map
00DB; 00FB; Case map
00DC; 00FC; Case map
00DD; 00FD; Case map
00DE; 00FE; Case map
00DF; 0073 0073; Case map
0100; 0101; Case map
0102; 0103; Case map
0104; 0105; Case map
0106; 0107; Case map
0108; 0109; Case map
010A; 010B; Case map
010C; 010D; Case map
010E; 010F; Case map
0110; 0111; Case map
0112; 0113; Case map
0114; 0115; Case map
0116; 0117; Case map
0118; 0119; Case map
011A; 011B; Case map
011C; 011D; Case map
```

```
011E; 011F; Case map
0120; 0121; Case map
0122; 0123; Case map
0124; 0125; Case map
0126; 0127; Case map
0128; 0129; Case map
012A; 012B; Case map
012C; 012D; Case map
012E; 012F; Case map
0130; 0069 0307; Case map
0132; 0133; Case map
0134; 0135; Case map
0136; 0137; Case map
0139; 013A; Case map
013B; 013C; Case map
013D; 013E; Case map
013F; 0140; Case map
0141; 0142; Case map
0143; 0144; Case map
0145; 0146; Case map
0147; 0148; Case map
0149; 02BC 006E; Case map
014A; 014B; Case map
014C; 014D; Case map
014E; 014F; Case map
0150; 0151; Case map
0152; 0153; Case map
0154; 0155; Case map
0156; 0157; Case map
0158; 0159; Case map
015A; 015B; Case map
015C; 015D; Case map
015E; 015F; Case map
0160; 0161; Case map
0162; 0163; Case map
0164; 0165; Case map
0166; 0167; Case map
0168; 0169; Case map
016A; 016B; Case map
016C; 016D; Case map
016E; 016F; Case map
0170; 0171; Case map
0172; 0173; Case map
0174; 0175; Case map
0176; 0177; Case map
0178; 00FF; Case map
0179; 017A; Case map
017B; 017C; Case map
```

```
017D; 017E; Case map
017F; 0073; Case map
0181; 0253; Case map
0182; 0183; Case map
0184; 0185; Case map
0186; 0254; Case map
0187; 0188; Case map
0189; 0256; Case map
018A; 0257; Case map
018B; 018C; Case map
018E; 01DD; Case map
018F; 0259; Case map
0190; 025B; Case map
0191; 0192; Case map
0193; 0260; Case map
0194; 0263; Case map
0196; 0269; Case map
0197; 0268; Case map
0198; 0199; Case map
019C; 026F; Case map
019D; 0272; Case map
019F; 0275; Case map
01A0; 01A1; Case map
01A2; 01A3; Case map
01A4; 01A5; Case map
01A6; 0280; Case map
01A7; 01A8; Case map
01A9; 0283; Case map
01AC; 01AD; Case map
01AE; 0288; Case map
01AF; 01B0; Case map
01B1; 028A; Case map
01B2; 028B; Case map
01B3; 01B4; Case map
01B5; 01B6; Case map
01B7; 0292; Case map
01B8; 01B9; Case map
01BC; 01BD; Case map
01C4; 01C6; Case map
01C5; 01C6; Case map
01C7; 01C9; Case map
01C8; 01C9; Case map
01CA; 01CC; Case map
01CB; 01CC; Case map
01CD; 01CE; Case map
01CF; 01D0; Case map
01D1; 01D2; Case map
01D3; 01D4; Case map
```

```
01D5; 01D6; Case map
01D7; 01D8; Case map
01D9; 01DA; Case map
01DB; 01DC; Case map
01DE; 01DF; Case map
01E0; 01E1; Case map
01E2; 01E3; Case map
01E4; 01E5; Case map
01E6; 01E7; Case map
01E8; 01E9; Case map
01EA; 01EB; Case map
01EC; 01ED; Case map
01EE; 01EF; Case map
01F0; 006A 030C; Case map
01F1; 01F3; Case map
01F2; 01F3; Case map
01F4; 01F5; Case map
01F6; 0195; Case map
01F7; 01BF; Case map
01F8; 01F9; Case map
01FA; 01FB; Case map
01FC; 01FD; Case map
01FE; 01FF; Case map
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FB04; 0066 0066 006C; Case map
FB05; 0073 0074; Case map
FB06; 0073 0074; Case map
FB13; 0574 0576; Case map
FB14; 0574 0565; Case map
FB15; 0574 056B; Case map
FB16; 057E 0576; Case map
FB17; 0574 056D; Case map
FF21; FF41; Case map
FF22; FF42; Case map
FF23; FF43; Case map
FF24; FF44; Case map
FF25; FF45; Case map
FF26; FF46; Case map
FF27; FF47; Case map
FF28; FF48; Case map
FF29; FF49; Case map
FF2A; FF4A; Case map
FF2B; FF4B; Case map
FF2C; FF4C; Case map
FF2D; FF4D; Case map
FF2E; FF4E; Case map
FF2F; FF4F; Case map
FF30; FF50; Case map
FF31; FF51; Case map
FF32; FF52; Case map
FF33; FF53; Case map
FF34; FF54; Case map
FF35; FF55; Case map
FF36; FF56; Case map
FF37; FF57; Case map
FF38; FF58; Case map
FF39; FF59; Case map
FF3A; FF5A; Case map
10400; 10428; Case map
10401; 10429; Case map
10402; 1042A; Case map
10403; 1042B; Case map
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10404; 1042C; Case map
10405; 1042D; Case map
10406; 1042E; Case map
10407; 1042F; Case map
10408; 10430; Case map
10409; 10431; Case map
1040A; 10432; Case map
1040B; 10433; Case map
1040C; 10434; Case map
1040D; 10435; Case map
1040E; 10436; Case map
1040F; 10437; Case map
10410; 10438; Case map
10411; 10439; Case map
10412; 1043A; Case map
10413; 1043B; Case map
10414; 1043C; Case map
10415; 1043D; Case map
10416; 1043E; Case map
10417; 1043F; Case map
10418; 10440; Case map
10419; 10441; Case map
1041A; 10442; Case map
1041B; 10443; Case map
1041C; 10444; Case map
1041D; 10445; Case map
1041E; 10446; Case map
1041F; 10447; Case map
10420; 10448; Case map
10421; 10449; Case map
10422; 1044A; Case map
10423; 1044B; Case map
10424; 1044C; Case map
10425; 1044D; Case map
1D400; 0061; Additional folding
1D401; 0062; Additional folding
1D402; 0063; Additional folding
1D403; 0064; Additional folding
1D404; 0065; Additional folding
1D405; 0066; Additional folding
1D406; 0067; Additional folding
1D407; 0068; Additional folding
1D408; 0069; Additional folding
1D409; 006A; Additional folding
1D40A; 006B; Additional folding
1D40B; 006C; Additional folding
1D40C; 006D; Additional folding
1D40D; 006E; Additional folding
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1D40E; 006F; Additional folding
1D40F; 0070; Additional folding
1D410; 0071; Additional folding
1D411; 0072; Additional folding
1D412; 0073; Additional folding
1D413; 0074; Additional folding
1D414; 0075; Additional folding
1D415; 0076; Additional folding
1D416; 0077; Additional folding
1D417; 0078; Additional folding
1D418; 0079; Additional folding
1D419; 007A; Additional folding
1D434; 0061; Additional folding
1D435; 0062; Additional folding
1D436; 0063; Additional folding
1D437; 0064; Additional folding
1D438; 0065; Additional folding
1D439; 0066; Additional folding
1D43A; 0067; Additional folding
1D43B; 0068; Additional folding
1D43C; 0069; Additional folding
1D43D; 006A; Additional folding
1D43E; 006B; Additional folding
1D43F; 006C; Additional folding
1D440; 006D; Additional folding
1D441; 006E; Additional folding
1D442; 006F; Additional folding
1D443; 0070; Additional folding
1D444; 0071; Additional folding
1D445; 0072; Additional folding
1D446; 0073; Additional folding
1D447; 0074; Additional folding
1D448; 0075; Additional folding
1D449; 0076; Additional folding
1D44A; 0077; Additional folding
1D44B; 0078; Additional folding
1D44C; 0079; Additional folding
1D44D; 007A; Additional folding
1D468; 0061; Additional folding
1D469; 0062; Additional folding
1D46A; 0063; Additional folding
1D46B; 0064; Additional folding
1D46C; 0065; Additional folding
1D46D; 0066; Additional folding
1D46E; 0067; Additional folding
1D46F; 0068; Additional folding
1D470; 0069; Additional folding
1D471; 006A; Additional folding
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1D472; 006B; Additional folding
1D473; 006C; Additional folding
1D474; 006D; Additional folding
1D475; 006E; Additional folding
1D476; 006F; Additional folding
1D477; 0070; Additional folding
1D478; 0071; Additional folding
1D479; 0072; Additional folding
1D47A; 0073; Additional folding
1D47B; 0074; Additional folding
1D47C; 0075; Additional folding
1D47D; 0076; Additional folding
1D47E; 0077; Additional folding
1D47F; 0078; Additional folding
1D480; 0079; Additional folding
1D481; 007A; Additional folding
1D49C; 0061; Additional folding
1D49E; 0063; Additional folding
1D49F; 0064; Additional folding
1D4A2; 0067; Additional folding
1D4A5; 006A; Additional folding
1D4A6; 006B; Additional folding
1D4A9; 006E; Additional folding
1D4AA; 006F; Additional folding
1D4AB; 0070; Additional folding
1D4AC; 0071; Additional folding
1D4AE; 0073; Additional folding
1D4AF; 0074; Additional folding
1D4B0; 0075; Additional folding
1D4B1; 0076; Additional folding
1D4B2; 0077; Additional folding
1D4B3; 0078; Additional folding
1D4B4; 0079; Additional folding
1D4B5; 007A; Additional folding
1D4D0; 0061; Additional folding
1D4D1; 0062; Additional folding
1D4D2; 0063; Additional folding
1D4D3; 0064; Additional folding
1D4D4; 0065; Additional folding
1D4D5; 0066; Additional folding
1D4D6; 0067; Additional folding
1D4D7; 0068; Additional folding
1D4D8; 0069; Additional folding
1D4D9; 006A; Additional folding
1D4DA; 006B; Additional folding
1D4DB; 006C; Additional folding
1D4DC; 006D; Additional folding
1D4DD; 006E; Additional folding
```

```
1D4DE; 006F; Additional folding
1D4DF; 0070; Additional folding
1D4E0; 0071; Additional folding
1D4E1; 0072; Additional folding
1D4E2; 0073; Additional folding
1D4E3; 0074; Additional folding
1D4E4; 0075; Additional folding
1D4E5; 0076; Additional folding
1D4E6; 0077; Additional folding
1D4E7; 0078; Additional folding
1D4E8; 0079; Additional folding
1D4E9; 007A; Additional folding
1D504; 0061; Additional folding
1D505; 0062; Additional folding
1D507; 0064; Additional folding
1D508; 0065; Additional folding
1D509; 0066; Additional folding
1D50A; 0067; Additional folding
1D50D; 006A; Additional folding
1D50E; 006B; Additional folding
1D50F; 006C; Additional folding
1D510; 006D; Additional folding
1D511; 006E; Additional folding
1D512; 006F; Additional folding
1D513; 0070; Additional folding
1D514; 0071; Additional folding
1D516; 0073; Additional folding
1D517; 0074; Additional folding
1D518; 0075; Additional folding
1D519; 0076; Additional folding
1D51A; 0077; Additional folding
1D51B; 0078; Additional folding
1D51C; 0079; Additional folding
1D538; 0061; Additional folding
1D539; 0062; Additional folding
1D53B; 0064; Additional folding
1D53C; 0065; Additional folding
1D53D; 0066; Additional folding
1D53E; 0067; Additional folding
1D540; 0069; Additional folding
1D541; 006A; Additional folding
1D542; 006B; Additional folding
1D543; 006C; Additional folding
1D544; 006D; Additional folding
1D546; 006F; Additional folding
1D54A; 0073; Additional folding
1D54B; 0074; Additional folding
1D54C; 0075; Additional folding
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1D54D; 0076; Additional folding
1D54E; 0077; Additional folding
1D54F; 0078; Additional folding
1D550; 0079; Additional folding
1D56C; 0061; Additional folding
1D56D; 0062; Additional folding
1D56E; 0063; Additional folding
1D56F; 0064; Additional folding
1D570; 0065; Additional folding
1D571; 0066; Additional folding
1D572; 0067; Additional folding
1D573; 0068; Additional folding
1D574; 0069; Additional folding
1D575; 006A; Additional folding
1D576; 006B; Additional folding
1D577; 006C; Additional folding
1D578; 006D; Additional folding
1D579; 006E; Additional folding
1D57A; 006F; Additional folding
1D57B; 0070; Additional folding
1D57C; 0071; Additional folding
1D57D; 0072; Additional folding
1D57E; 0073; Additional folding
1D57F; 0074; Additional folding
1D580; 0075; Additional folding
1D581; 0076; Additional folding
1D582; 0077; Additional folding
1D583; 0078; Additional folding
1D584; 0079; Additional folding
1D585; 007A; Additional folding
1D5A0; 0061; Additional folding
1D5A1; 0062; Additional folding
1D5A2; 0063; Additional folding
1D5A3; 0064; Additional folding
1D5A4; 0065; Additional folding
1D5A5; 0066; Additional folding
1D5A6; 0067; Additional folding
1D5A7; 0068; Additional folding
1D5A8; 0069; Additional folding
1D5A9; 006A; Additional folding
1D5AA; 006B; Additional folding
1D5AB; 006C; Additional folding
1D5AC; 006D; Additional folding
1D5AD; 006E; Additional folding
1D5AE; 006F; Additional folding
1D5AF; 0070; Additional folding
1D5B0; 0071; Additional folding
1D5B1; 0072; Additional folding
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1D5B2; 0073; Additional folding
1D5B3; 0074; Additional folding
1D5B4; 0075; Additional folding
1D5B5; 0076; Additional folding
1D5B6; 0077; Additional folding
1D5B7; 0078; Additional folding
1D5B8; 0079; Additional folding
1D5B9; 007A; Additional folding
1D5D4; 0061; Additional folding
1D5D5; 0062; Additional folding
1D5D6; 0063; Additional folding
1D5D7; 0064; Additional folding
1D5D8; 0065; Additional folding
1D5D9; 0066; Additional folding
1D5DA; 0067; Additional folding
1D5DB; 0068; Additional folding
1D5DC; 0069; Additional folding
1D5DD; 006A; Additional folding
1D5DE; 006B; Additional folding
1D5DF; 006C; Additional folding
1D5E0; 006D; Additional folding
1D5E1; 006E; Additional folding
1D5E2; 006F; Additional folding
1D5E3; 0070; Additional folding
1D5E4; 0071; Additional folding
1D5E5; 0072; Additional folding
1D5E6; 0073; Additional folding
1D5E7; 0074; Additional folding
1D5E8; 0075; Additional folding
1D5E9; 0076; Additional folding
1D5EA; 0077; Additional folding
1D5EB; 0078; Additional folding
1D5EC; 0079; Additional folding
1D5ED; 007A; Additional folding
1D608; 0061; Additional folding
1D609; 0062; Additional folding
1D60A; 0063; Additional folding
1D60B; 0064; Additional folding
1D60C; 0065; Additional folding
1D60D; 0066; Additional folding
1D60E; 0067; Additional folding
1D60F; 0068; Additional folding
1D610; 0069; Additional folding
1D611; 006A; Additional folding
1D612; 006B; Additional folding
1D613; 006C; Additional folding
1D614; 006D; Additional folding
1D615; 006E; Additional folding
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1D616; 006F; Additional folding
1D617; 0070; Additional folding
1D618; 0071; Additional folding
1D619; 0072; Additional folding
1D61A; 0073; Additional folding
1D61B; 0074; Additional folding
1D61C; 0075; Additional folding
1D61D; 0076; Additional folding
1D61E; 0077; Additional folding
1D61F; 0078; Additional folding
1D620; 0079; Additional folding
1D621; 007A; Additional folding
1D63C; 0061; Additional folding
1D63D; 0062; Additional folding
1D63E; 0063; Additional folding
1D63F; 0064; Additional folding
1D640; 0065; Additional folding
1D641; 0066; Additional folding
1D642; 0067; Additional folding
1D643; 0068; Additional folding
1D644; 0069; Additional folding
1D645; 006A; Additional folding
1D646; 006B; Additional folding
1D647; 006C; Additional folding
1D648; 006D; Additional folding
1D649; 006E; Additional folding
1D64A; 006F; Additional folding
1D64B; 0070; Additional folding
1D64C; 0071; Additional folding
1D64D; 0072; Additional folding
1D64E; 0073; Additional folding
1D64F; 0074; Additional folding
1D650; 0075; Additional folding
1D651; 0076; Additional folding
1D652; 0077; Additional folding
1D653; 0078; Additional folding
1D654; 0079; Additional folding
1D655; 007A; Additional folding
1D670; 0061; Additional folding
1D671; 0062; Additional folding
1D672; 0063; Additional folding
1D673; 0064; Additional folding
1D674; 0065; Additional folding
1D675; 0066; Additional folding
1D676; 0067; Additional folding
1D677; 0068; Additional folding
1D678; 0069; Additional folding
1D679; 006A; Additional folding
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```
1D67A; 006B; Additional folding
1D67B; 006C; Additional folding
1D67C; 006D; Additional folding
1D67D; 006E; Additional folding
1D67E; 006F; Additional folding
1D67F; 0070; Additional folding
1D680; 0071; Additional folding
1D681; 0072; Additional folding
1D682; 0073; Additional folding
1D683; 0074; Additional folding
1D684; 0075; Additional folding
1D685; 0076; Additional folding
1D686; 0077; Additional folding
1D687; 0078; Additional folding
1D688; 0079; Additional folding
1D689; 007A; Additional folding
1D6A8; 03B1; Additional folding
1D6A9; 03B2; Additional folding
1D6AA; 03B3; Additional folding
1D6AB; 03B4; Additional folding
1D6AC; 03B5; Additional folding
1D6AD; 03B6; Additional folding
1D6AE; 03B7; Additional folding
1D6AF; 03B8; Additional folding
1D6B0; 03B9; Additional folding
1D6B1; 03BA; Additional folding
1D6B2; 03BB; Additional folding
1D6B3; 03BC; Additional folding
1D6B4; 03BD; Additional folding
1D6B5; 03BE; Additional folding
1D6B6; 03BF; Additional folding
1D6B7; 03C0; Additional folding
1D6B8; 03C1; Additional folding
1D6B9; 03B8; Additional folding
1D6BA; 03C3; Additional folding
1D6BB; 03C4; Additional folding
1D6BC; 03C5; Additional folding
1D6BD; 03C6; Additional folding
1D6BE; 03C7; Additional folding
1D6BF; 03C8; Additional folding
1D6C0; 03C9; Additional folding
1D6D3; 03C3; Additional folding
1D6E2; 03B1; Additional folding
1D6E3; 03B2; Additional folding
1D6E4; 03B3; Additional folding
1D6E5; 03B4; Additional folding
1D6E6; 03B5; Additional folding
1D6E7; 03B6; Additional folding
```

```
1D6E8; 03B7; Additional folding
1D6E9; 03B8; Additional folding
1D6EA; 03B9; Additional folding
1D6EB; 03BA; Additional folding
1D6EC; 03BB; Additional folding
1D6ED; 03BC; Additional folding
1D6EE; 03BD; Additional folding
1D6EF; 03BE; Additional folding
1D6F0; 03BF; Additional folding
1D6F1; 03C0; Additional folding
1D6F2; 03C1; Additional folding
1D6F3; 03B8; Additional folding
1D6F4; 03C3; Additional folding
1D6F5; 03C4; Additional folding
1D6F6; 03C5; Additional folding
1D6F7; 03C6; Additional folding
1D6F8; 03C7; Additional folding
1D6F9; 03C8; Additional folding
1D6FA; 03C9; Additional folding
1D70D; 03C3; Additional folding
1D71C; 03B1; Additional folding
1D71D; 03B2; Additional folding
1D71E; 03B3; Additional folding
1D71F; 03B4; Additional folding
1D720; 03B5; Additional folding
1D721; 03B6; Additional folding
1D722; 03B7; Additional folding
1D723; 03B8; Additional folding
1D724; 03B9; Additional folding
1D725; 03BA; Additional folding
1D726; 03BB; Additional folding
1D727; 03BC; Additional folding
1D728; 03BD; Additional folding
1D729; 03BE; Additional folding
1D72A; 03BF; Additional folding
1D72B; 03C0; Additional folding
1D72C; 03C1; Additional folding
1D72D; 03B8; Additional folding
1D72E; 03C3; Additional folding
1D72F; 03C4; Additional folding
1D730; 03C5; Additional folding
1D731; 03C6; Additional folding
1D732; 03C7; Additional folding
1D733; 03C8; Additional folding
1D734; 03C9; Additional folding
1D747; 03C3; Additional folding
1D756; 03B1; Additional folding
1D757; 03B2; Additional folding
```

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1D758; 03B3; Additional folding
1D759; 03B4; Additional folding
1D75A; 03B5; Additional folding
1D75B; 03B6; Additional folding
1D75C; 03B7; Additional folding
1D75D; 03B8; Additional folding
1D75E; 03B9; Additional folding
1D75F; 03BA; Additional folding
1D760; 03BB; Additional folding
1D761; 03BC; Additional folding
1D762; 03BD; Additional folding
1D763; 03BE; Additional folding
1D764; 03BF; Additional folding
1D765; 03C0; Additional folding
1D766; 03C1; Additional folding
1D767; 03B8; Additional folding
1D768; 03C3; Additional folding
1D769; 03C4; Additional folding
1D76A; 03C5; Additional folding
1D76B; 03C6; Additional folding
1D76C; 03C7; Additional folding
1D76D; 03C8; Additional folding
1D76E; 03C9; Additional folding
1D781; 03C3; Additional folding
1D790; 03B1; Additional folding
1D791; 03B2; Additional folding
1D792; 03B3; Additional folding
1D793; 03B4; Additional folding
1D794; 03B5; Additional folding
1D795; 03B6; Additional folding
1D796; 03B7; Additional folding
1D797; 03B8; Additional folding
1D798; 03B9; Additional folding
1D799; 03BA; Additional folding
1D79A; 03BB; Additional folding
1D79B; 03BC; Additional folding
1D79C; 03BD; Additional folding
1D79D; 03BE; Additional folding
1D79E; 03BF; Additional folding
1D79F; 03C0; Additional folding
1D7A0; 03C1; Additional folding
1D7A1; 03B8; Additional folding
1D7A2; 03C3; Additional folding
1D7A3; 03C4; Additional folding
1D7A4; 03C5; Additional folding
1D7A5; 03C6; Additional folding
1D7A6; 03C7; Additional folding
1D7A7; 03C8; Additional folding
```

```
   1D7A8; 03C9; Additional folding
   1D7BB; 03C3; Additional folding
   ----- End Table B.2 -----
```

B.3 Mapping for case-folding used with no normalization

```
   ----- Start Table B.3 -----
   0041; 0061; Case map
   0042; 0062; Case map
   0043; 0063; Case map
   0044; 0064; Case map
   0045; 0065; Case map
   0046; 0066; Case map
   0047; 0067; Case map
   0048; 0068; Case map
   0049; 0069; Case map
   004A; 006A; Case map
   004B; 006B; Case map
   004C; 006C; Case map
   004D; 006D; Case map
   004E; 006E; Case map
   004F; 006F; Case map
   0050; 0070; Case map
   0051; 0071; Case map
   0052; 0072; Case map
   0053; 0073; Case map
   0054; 0074; Case map
   0055; 0075; Case map
   0056; 0076; Case map
   0057; 0077; Case map
   0058; 0078; Case map
   0059; 0079; Case map
   005A; 007A; Case map
   00B5; 03BC; Case map
   00C0; 00E0; Case map
   00C1; 00E1; Case map
   00C2; 00E2; Case map
   00C3; 00E3; Case map
   00C4; 00E4; Case map
   00C5; 00E5; Case map
   00C6; 00E6; Case map
   00C7; 00E7; Case map
   00C8; 00E8; Case map
   00C9; 00E9; Case map
   00CA; 00EA; Case map
   00CB; 00EB; Case map
   00CC; 00EC; Case map
   00CD; 00ED; Case map
```

```
00CE; 00EE; Case map
00CF; 00EF; Case map
00D0; 00F0; Case map
00D1; 00F1; Case map
00D2; 00F2; Case map
00D3; 00F3; Case map
00D4; 00F4; Case map
00D5; 00F5; Case map
00D6; 00F6; Case map
00D8; 00F8; Case map
00D9; 00F9; Case map
00DA; 00FA; Case map
00DB; 00FB; Case map
00DC; 00FC; Case map
00DD; 00FD; Case map
00DE; 00FE; Case map
00DF; 0073 0073; Case map
0100; 0101; Case map
0102; 0103; Case map
0104; 0105; Case map
0106; 0107; Case map
0108; 0109; Case map
010A; 010B; Case map
010C; 010D; Case map
010E; 010F; Case map
0110; 0111; Case map
0112; 0113; Case map
0114; 0115; Case map
0116; 0117; Case map
0118; 0119; Case map
011A; 011B; Case map
011C; 011D; Case map
011E; 011F; Case map
0120; 0121; Case map
0122; 0123; Case map
0124; 0125; Case map
0126; 0127; Case map
0128; 0129; Case map
012A; 012B; Case map
012C; 012D; Case map
012E; 012F; Case map
0130; 0069 0307; Case map
0132; 0133; Case map
0134; 0135; Case map
0136; 0137; Case map
0139; 013A; Case map
013B; 013C; Case map
013D; 013E; Case map
```

```
013F; 0140; Case map
0141; 0142; Case map
0143; 0144; Case map
0145; 0146; Case map
0147; 0148; Case map
0149; 02BC 006E; Case map
014A; 014B; Case map
014C; 014D; Case map
014E; 014F; Case map
0150; 0151; Case map
0152; 0153; Case map
0154; 0155; Case map
0156; 0157; Case map
0158; 0159; Case map
015A; 015B; Case map
015C; 015D; Case map
015E; 015F; Case map
0160; 0161; Case map
0162; 0163; Case map
0164; 0165; Case map
0166; 0167; Case map
0168; 0169; Case map
016A; 016B; Case map
016C; 016D; Case map
016E; 016F; Case map
0170; 0171; Case map
0172; 0173; Case map
0174; 0175; Case map
0176; 0177; Case map
0178; 00FF; Case map
0179; 017A; Case map
017B; 017C; Case map
017D; 017E; Case map
017F; 0073; Case map
0181; 0253; Case map
0182; 0183; Case map
0184; 0185; Case map
0186; 0254; Case map
0187; 0188; Case map
0189; 0256; Case map
018A; 0257; Case map
018B; 018C; Case map
018E; 01DD; Case map
018F; 0259; Case map
0190; 025B; Case map
0191; 0192; Case map
0193; 0260; Case map
0194; 0263; Case map
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0196; 0269; Case map
0197; 0268; Case map
0198; 0199; Case map
019C; 026F; Case map
019D; 0272; Case map
019F; 0275; Case map
01A0; 01A1; Case map
01A2; 01A3; Case map
01A4; 01A5; Case map
01A6; 0280; Case map
01A7; 01A8; Case map
01A9; 0283; Case map
01AC; 01AD; Case map
01AE; 0288; Case map
01AF; 01B0; Case map
01B1; 028A; Case map
01B2; 028B; Case map
01B3; 01B4; Case map
01B5; 01B6; Case map
01B7; 0292; Case map
01B8; 01B9; Case map
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     ----- End Table B.3 -----
```

C. Prohibition tables

   The tables in this appendix consist of lines with one prohibited code
   point per line. The format of the lines are the value of the code
   point, a semicolon, and a comment which is the name of the code
   point.

C.1 Space characters

C.1.1 ASCII space characters

```
     ----- Start Table C.1.1 -----
     0020; SPACE
     ----- End Table C.1.1 -----
```

C.1.2 Non-ASCII space characters
    ----- Start Table C.1.2 -----
    00A0; NO-BREAK SPACE
    1680; OGHAM SPACE MARK
    2000; EN QUAD
    2001; EM QUAD
    2002; EN SPACE
    2003; EM SPACE
    2004; THREE-PER-EM SPACE
    2005; FOUR-PER-EM SPACE
    2006; SIX-PER-EM SPACE
    2007; FIGURE SPACE
    2008; PUNCTUATION SPACE
    2009; THIN SPACE
    200A; HAIR SPACE
    200B; ZERO WIDTH SPACE
    202F; NARROW NO-BREAK SPACE
    205F; MEDIUM MATHEMATICAL SPACE
    3000; IDEOGRAPHIC SPACE
    ----- End Table C.1.2 -----

C.2 Control characters

C.2.1 ASCII control characters

    ----- Start Table C.2.1 -----
    0000-001F; [CONTROL CHARACTERS]
    007F; DELETE
    ----- End Table C.2.1 -----

C.2.2 Non-ASCII control characters

    ----- Start Table C.2.2 -----
    0080-009F; [CONTROL CHARACTERS]
    06DD; ARABIC END OF AYAH
    070F; SYRIAC ABBREVIATION MARK
    180E; MONGOLIAN VOWEL SEPARATOR
    200C; ZERO WIDTH NON-JOINER
    200D; ZERO WIDTH JOINER
    2028; LINE SEPARATOR
    2029; PARAGRAPH SEPARATOR
    2060; WORD JOINER
    2061; FUNCTION APPLICATION
    2062; INVISIBLE TIMES
    2063; INVISIBLE SEPARATOR
    206A-206F; [CONTROL CHARACTERS]
    FEFF; ZERO WIDTH NO-BREAK SPACE
    FFF9-FFFC; [CONTROL CHARACTERS]

```
   1D173-1D17A; [MUSICAL CONTROL CHARACTERS]
   ----- End Table C.2.2 -----
```

C.3 Private use

```
   ----- Start Table C.3 -----
   E000-F8FF; [PRIVATE USE, PLANE 0]
   F0000-FFFFD; [PRIVATE USE, PLANE 15]
   100000-10FFFD; [PRIVATE USE, PLANE 16]
   ----- End Table C.3 -----
```

C.4 Non-character code points

```
   ----- Start Table C.4 -----
   FDD0-FDEF; [NONCHARACTER CODE POINTS]
   FFFE-FFFF; [NONCHARACTER CODE POINTS]
   1FFFE-1FFFF; [NONCHARACTER CODE POINTS]
   2FFFE-2FFFF; [NONCHARACTER CODE POINTS]
   3FFFE-3FFFF; [NONCHARACTER CODE POINTS]
   4FFFE-4FFFF; [NONCHARACTER CODE POINTS]
   5FFFE-5FFFF; [NONCHARACTER CODE POINTS]
   6FFFE-6FFFF; [NONCHARACTER CODE POINTS]
   7FFFE-7FFFF; [NONCHARACTER CODE POINTS]
   8FFFE-8FFFF; [NONCHARACTER CODE POINTS]
   9FFFE-9FFFF; [NONCHARACTER CODE POINTS]
   AFFFE-AFFFF; [NONCHARACTER CODE POINTS]
   BFFFE-BFFFF; [NONCHARACTER CODE POINTS]
   CFFFE-CFFFF; [NONCHARACTER CODE POINTS]
   DFFFE-DFFFF; [NONCHARACTER CODE POINTS]
   EFFFE-EFFFF; [NONCHARACTER CODE POINTS]
   FFFFE-FFFFF; [NONCHARACTER CODE POINTS]
   10FFFE-10FFFF; [NONCHARACTER CODE POINTS]
   ----- End Table C.4 -----
```

C.5 Surrogate codes

```
   ----- Start Table C.5 -----
   D800-DFFF; [SURROGATE CODES]
   ----- End Table C.5 -----
```

C.6 Inappropriate for plain text

```
   ----- Start Table C.6 -----
   FFF9; INTERLINEAR ANNOTATION ANCHOR
   FFFA; INTERLINEAR ANNOTATION SEPARATOR
   FFFB; INTERLINEAR ANNOTATION TERMINATOR
   FFFC; OBJECT REPLACEMENT CHARACTER
   FFFD; REPLACEMENT CHARACTER
```

```
   ----- End Table C.6 -----
```

C.7 Inappropriate for canonical representation

```
   ----- Start Table C.7 -----
   2FF0-2FFB; [IDEOGRAPHIC DESCRIPTION CHARACTERS]
   ----- End Table C.7 -----
```

C.8 Change display properties or are deprecated

```
   ----- Start Table C.8 -----
   0340; COMBINING GRAVE TONE MARK
   0341; COMBINING ACUTE TONE MARK
   200E; LEFT-TO-RIGHT MARK
   200F; RIGHT-TO-LEFT MARK
   202A; LEFT-TO-RIGHT EMBEDDING
   202B; RIGHT-TO-LEFT EMBEDDING
   202C; POP DIRECTIONAL FORMATTING
   202D; LEFT-TO-RIGHT OVERRIDE
   202E; RIGHT-TO-LEFT OVERRIDE
   206A; INHIBIT SYMMETRIC SWAPPING
   206B; ACTIVATE SYMMETRIC SWAPPING
   206C; INHIBIT ARABIC FORM SHAPING
   206D; ACTIVATE ARABIC FORM SHAPING
   206E; NATIONAL DIGIT SHAPES
   206F; NOMINAL DIGIT SHAPES
   ----- End Table C.8 -----
```

C.9 Tagging characters

```
   ----- Start Table C.9 -----
   E0001; LANGUAGE TAG
   E0020-E007F; [TAGGING CHARACTERS]
   ----- End Table C.9 -----
```

D. Bidirectional tables

D.1 Characters with bidirectional property "R" or "AL"

```
   ----- Start Table D.1 -----
   05BE
   05C0
   05C3
   05D0-05EA
   05F0-05F4
   061B
   061F
   0621-063A
```

```
   0640-064A
   066D-066F
   0671-06D5
   06DD
   06E5-06E6
   06FA-06FE
   0700-070D
   0710
   0712-072C
   0780-07A5
   07B1
   200F
   FB1D
   FB1F-FB28
   FB2A-FB36
   FB38-FB3C
   FB3E
   FB40-FB41
   FB43-FB44
   FB46-FBB1
   FBD3-FD3D
   FD50-FD8F
   FD92-FDC7
   FDF0-FDFC
   FE70-FE74
   FE76-FEFC
   ----- End Table D.1 -----
```

D.2 Characters with bidirectional property "L"

```
   ----- Start Table D.2 -----
   0041-005A
   0061-007A
   00AA
   00B5
   00BA
   00C0-00D6
   00D8-00F6
   00F8-0220
   0222-0233
   0250-02AD
   02B0-02B8
   02BB-02C1
   02D0-02D1
   02E0-02E4
   02EE
   037A
   0386
```

```
0388-038A
038C
038E-03A1
03A3-03CE
03D0-03F5
0400-0482
048A-04CE
04D0-04F5
04F8-04F9
0500-050F
0531-0556
0559-055F
0561-0587
0589
0903
0905-0939
093D-0940
0949-094C
0950
0958-0961
0964-0970
0982-0983
0985-098C
098F-0990
0993-09A8
09AA-09B0
09B2
09B6-09B9
09BE-09C0
09C7-09C8
09CB-09CC
09D7
09DC-09DD
09DF-09E1
09E6-09F1
09F4-09FA
0A05-0A0A
0A0F-0A10
0A13-0A28
0A2A-0A30
0A32-0A33
0A35-0A36
0A38-0A39
0A3E-0A40
0A59-0A5C
0A5E
0A66-0A6F
0A72-0A74
```

    0A83
    0A85-0A8B
    0A8D
    0A8F-0A91
    0A93-0AA8
    0AAA-0AB0
    0AB2-0AB3
    0AB5-0AB9
    0ABD-0AC0
    0AC9
    0ACB-0ACC
    0AD0
    0AE0
    0AE6-0AEF
    0B02-0B03
    0B05-0B0C
    0B0F-0B10
    0B13-0B28
    0B2A-0B30
    0B32-0B33
    0B36-0B39
    0B3D-0B3E
    0B40
    0B47-0B48
    0B4B-0B4C
    0B57
    0B5C-0B5D
    0B5F-0B61
    0B66-0B70
    0B83
    0B85-0B8A
    0B8E-0B90
    0B92-0B95
    0B99-0B9A
    0B9C
    0B9E-0B9F
    0BA3-0BA4
    0BA8-0BAA
    0BAE-0BB5
    0BB7-0BB9
    0BBE-0BBF
    0BC1-0BC2
    0BC6-0BC8
    0BCA-0BCC
    0BD7
    0BE7-0BF2
    0C01-0C03
    0C05-0C0C

```
0C0E-0C10
0C12-0C28
0C2A-0C33
0C35-0C39
0C41-0C44
0C60-0C61
0C66-0C6F
0C82-0C83
0C85-0C8C
0C8E-0C90
0C92-0CA8
0CAA-0CB3
0CB5-0CB9
0CBE
0CC0-0CC4
0CC7-0CC8
0CCA-0CCB
0CD5-0CD6
0CDE
0CE0-0CE1
0CE6-0CEF
0D02-0D03
0D05-0D0C
0D0E-0D10
0D12-0D28
0D2A-0D39
0D3E-0D40
0D46-0D48
0D4A-0D4C
0D57
0D60-0D61
0D66-0D6F
0D82-0D83
0D85-0D96
0D9A-0DB1
0DB3-0DBB
0DBD
0DC0-0DC6
0DCF-0DD1
0DD8-0DDF
0DF2-0DF4
0E01-0E30
0E32-0E33
0E40-0E46
0E4F-0E5B
0E81-0E82
0E84
0E87-0E88
```

```
0E8A
0E8D
0E94-0E97
0E99-0E9F
0EA1-0EA3
0EA5
0EA7
0EAA-0EAB
0EAD-0EB0
0EB2-0EB3
0EBD
0EC0-0EC4
0EC6
0ED0-0ED9
0EDC-0EDD
0F00-0F17
0F1A-0F34
0F36
0F38
0F3E-0F47
0F49-0F6A
0F7F
0F85
0F88-0F8B
0FBE-0FC5
0FC7-0FCC
0FCF
1000-1021
1023-1027
1029-102A
102C
1031
1038
1040-1057
10A0-10C5
10D0-10F8
10FB
1100-1159
115F-11A2
11A8-11F9
1200-1206
1208-1246
1248
124A-124D
1250-1256
1258
125A-125D
1260-1286
```

    1288
    128A-128D
    1290-12AE
    12B0
    12B2-12B5
    12B8-12BE
    12C0
    12C2-12C5
    12C8-12CE
    12D0-12D6
    12D8-12EE
    12F0-130E
    1310
    1312-1315
    1318-131E
    1320-1346
    1348-135A
    1361-137C
    13A0-13F4
    1401-1676
    1681-169A
    16A0-16F0
    1700-170C
    170E-1711
    1720-1731
    1735-1736
    1740-1751
    1760-176C
    176E-1770
    1780-17B6
    17BE-17C5
    17C7-17C8
    17D4-17DA
    17DC
    17E0-17E9
    1810-1819
    1820-1877
    1880-18A8
    1E00-1E9B
    1EA0-1EF9
    1F00-1F15
    1F18-1F1D
    1F20-1F45
    1F48-1F4D
    1F50-1F57
    1F59
    1F5B
    1F5D

```
1F5F-1F7D
1F80-1FB4
1FB6-1FBC
1FBE
1FC2-1FC4
1FC6-1FCC
1FD0-1FD3
1FD6-1FDB
1FE0-1FEC
1FF2-1FF4
1FF6-1FFC
200E
2071
207F
2102
2107
210A-2113
2115
2119-211D
2124
2126
2128
212A-212D
212F-2131
2133-2139
213D-213F
2145-2149
2160-2183
2336-237A
2395
249C-24E9
3005-3007
3021-3029
3031-3035
3038-303C
3041-3096
309D-309F
30A1-30FA
30FC-30FF
3105-312C
3131-318E
3190-31B7
31F0-321C
3220-3243
3260-327B
327F-32B0
32C0-32CB
32D0-32FE
```

```
3300-3376
337B-33DD
33E0-33FE
3400-4DB5
4E00-9FA5
A000-A48C
AC00-D7A3
D800-FA2D
FA30-FA6A
FB00-FB06
FB13-FB17
FF21-FF3A
FF41-FF5A
FF66-FFBE
FFC2-FFC7
FFCA-FFCF
FFD2-FFD7
FFDA-FFDC
10300-1031E
10320-10323
10330-1034A
10400-10425
10428-1044D
1D000-1D0F5
1D100-1D126
1D12A-1D166
1D16A-1D172
1D183-1D184
1D18C-1D1A9
1D1AE-1D1DD
1D400-1D454
1D456-1D49C
1D49E-1D49F
1D4A2
1D4A5-1D4A6
1D4A9-1D4AC
1D4AE-1D4B9
1D4BB
1D4BD-1D4C0
1D4C2-1D4C3
1D4C5-1D505
1D507-1D50A
1D50D-1D514
1D516-1D51C
1D51E-1D539
1D53B-1D53E
1D540-1D544
1D546
```

```
   1D54A-1D550
   1D552-1D6A3
   1D6A8-1D7C9
   20000-2A6D6
   2F800-2FA1D
   F0000-FFFFD
   100000-10FFFD
   ----- End Table D.2 -----
```

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