

## Preparation of Internationalized Strings ("stringprep")

### Status of this Memo

This document specifies an Internet standards track protocol for the Internet community, and requests discussion and suggestions for improvements. Please refer to the current edition of the "Internet Official Protocol Standards" (STD 1) for the standardization state and status of this protocol. Distribution of this memo is unlimited.

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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 repertoires. 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 be 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]  
100000-10FFFFD; [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]  
EFFFF-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 bidirectional 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.

The IDN nameprep design team made many useful changes to the first document. That team and its advisors include:

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

Additional significant improvements were proposed by:

Jonathan Rosenne  
Kent Karlsson  
Scott Hollenbeck  
Dave Crocker  
Erik Nordmark  
Matitiah 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
1D800-1FFFFD
2A6D7-2F7FF
2FA1E-2FFFFD
30000-3FFFFD
40000-4FFFFD
50000-5FFFFD
60000-6FFFFD
70000-7FFFFD
80000-8FFFFD
90000-9FFFFD
A0000-AFFFFD
B0000-BFFFFD
C0000-CFFFFD
D0000-DFFFFD
E0000
E0002-E001F
E0080-EFFFFD
----- 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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33B7; 006D 0076; Additional folding  
33B8; 006B 0076; Additional folding  
33B9; 006D 0076; Additional folding  
33BA; 0070 0077; Additional folding  
33BB; 006E 0077; Additional folding  
33BC; 03BC 0077; Additional folding  
33BD; 006D 0077; Additional folding  
33BE; 006B 0077; Additional folding  
33BF; 006D 0077; Additional folding  
33C0; 006B 03C9; Additional folding  
33C1; 006D 03C9; Additional folding  
33C3; 0062 0071; Additional folding  
33C6; 0063 2215 006B 0067; Additional folding  
33C7; 0063 006F 002E; Additional folding  
33C8; 0064 0062; Additional folding  
33C9; 0067 0079; Additional folding  
33CB; 0068 0070; Additional folding  
33CD; 006B 006B; Additional folding

33CE; 006B 006D; Additional folding  
33D7; 0070 0068; Additional folding  
33D9; 0070 0070 006D; Additional folding  
33DA; 0070 0072; Additional folding  
33DC; 0073 0076; Additional folding  
33DD; 0077 0062; Additional folding  
FB00; 0066 0066; Case map  
FB01; 0066 0069; Case map  
FB02; 0066 006C; Case map  
FB03; 0066 0066 0069; Case map  
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  
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10401; 10429; Case map  
10402; 1042A; Case map  
10403; 1042B; Case map

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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  
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10413; 1043B; Case map  
10414; 1043C; Case map  
10415; 1043D; Case map  
10416; 1043E; Case map  
10417; 1043F; Case map  
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1041B; 10443; Case map  
1041C; 10444; Case map  
1041D; 10445; Case map  
1041E; 10446; Case map  
1041F; 10447; Case map  
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10421; 10449; Case map  
10422; 1044A; Case map  
10423; 1044B; Case map  
10424; 1044C; Case map  
10425; 1044D; Case map  
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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

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

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

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  
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1D571; 0066; Additional folding  
1D572; 0067; Additional folding  
1D573; 0068; Additional folding  
1D574; 0069; Additional folding  
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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  
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1D5A2; 0063; Additional folding  
1D5A3; 0064; Additional folding  
1D5A4; 0065; Additional folding  
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1D5A6; 0067; Additional folding  
1D5A7; 0068; Additional folding  
1D5A8; 0069; Additional folding  
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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

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  
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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  
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1D5DF; 006C; Additional folding  
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1D5E1; 006E; Additional folding  
1D5E2; 006F; Additional folding  
1D5E3; 0070; Additional folding  
1D5E4; 0071; Additional folding  
1D5E5; 0072; Additional folding  
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1D5E7; 0074; Additional folding  
1D5E8; 0075; Additional folding  
1D5E9; 0076; Additional folding  
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1D5EB; 0078; Additional folding  
1D5EC; 0079; Additional folding  
1D5ED; 007A; Additional folding  
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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

1D616; 006F; Additional folding  
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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  
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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

1D67A; 006B; Additional folding  
1D67B; 006C; Additional folding  
1D67C; 006D; Additional folding  
1D67D; 006E; Additional folding  
1D67E; 006F; Additional folding  
1D67F; 0070; Additional folding  
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1D681; 0072; Additional folding  
1D682; 0073; Additional folding  
1D683; 0074; Additional folding  
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1D686; 0077; Additional folding  
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1D688; 0079; Additional folding  
1D689; 007A; Additional folding  
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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  
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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

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  
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1FFC; 03C9 03B9; Case map  
2126; 03C9; Case map  
212A; 006B; Case map  
212B; 00E5; Case map  
2160; 2170; Case map  
2161; 2171; Case map  
2162; 2172; Case map  
2163; 2173; Case map  
2164; 2174; Case map  
2165; 2175; Case map  
2166; 2176; Case map  
2167; 2177; Case map  
2168; 2178; Case map  
2169; 2179; Case map  
216A; 217A; Case map  
216B; 217B; Case map  
216C; 217C; Case map  
216D; 217D; Case map  
216E; 217E; Case map  
216F; 217F; Case map  
24B6; 24D0; Case map  
24B7; 24D1; Case map  
24B8; 24D2; Case map  
24B9; 24D3; Case map  
24BA; 24D4; Case map  
24BB; 24D5; Case map  
24BC; 24D6; Case map  
24BD; 24D7; Case map  
24BE; 24D8; Case map  
24BF; 24D9; Case map  
24C0; 24DA; Case map  
24C1; 24DB; Case map  
24C2; 24DC; Case map  
24C3; 24DD; Case map  
24C4; 24DE; Case map  
24C5; 24DF; Case map  
24C6; 24E0; Case map  
24C7; 24E1; Case map  
24C8; 24E2; Case map  
24C9; 24E3; Case map  
24CA; 24E4; Case map  
24CB; 24E5; Case map  
24CC; 24E6; Case map  
24CD; 24E7; Case map  
24CE; 24E8; Case map

24CF; 24E9; Case map  
FB00; 0066 0066; Case map  
FB01; 0066 0069; Case map  
FB02; 0066 006C; Case map  
FB03; 0066 0066 0069; Case map  
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  
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
----- 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]  
100000-10FFFFD; [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]  
EFFFFE-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  
100000-10FFFFD  
----- End Table D.2 -----

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