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Version 14.0 – Core Specification

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Chapter 12

South and Central Asia-I

Official Scripts of India

The following South Asian scripts are described in this chapter:

<i>Devanagari</i>	<i>Gujarati</i>	<i>Telugu</i>
<i>Bengali (Bangla)</i>	<i>Oriya</i>	<i>Kannada</i>
<i>Gurmukhi</i>	<i>Tamil</i>	<i>Malayalam</i>

The scripts of South Asia share so many common features that a side-by-side comparison of a few will often reveal structural similarities even in the modern letterforms. With minor historical exceptions, they are written from left to right. They are all *abugidas* in which most symbols stand for a consonant plus an inherent vowel (usually the sound /a/). Word-initial vowels in many of these scripts have distinct symbols, and word-internal vowels are usually written by juxtaposing a vowel sign in the vicinity of the affected consonant. Absence of the inherent vowel, when that occurs, is frequently marked with a special sign. In the Unicode Standard, this sign is denoted by the Sanskrit word *virāma*. In some languages, another designation is preferred. In Hindi, for example, the word *hal* refers to the character itself, and *halant* refers to the consonant that has its inherent vowel suppressed; in Tamil, the word *pulli* is used. The virama sign nominally serves to suppress the inherent vowel of the consonant to which it is applied; it is a combining character, with its shape varying from script to script.

Most of the scripts of South Asia, from north of the Himalayas to Sri Lanka in the south, from Pakistan in the west to the easternmost islands of Indonesia, are derived from the ancient Brahmi script. The oldest lengthy inscriptions of India, the edicts of Ashoka from the third century BCE, were written in two scripts, Kharoshthi and Brahmi. These are both ultimately of Semitic origin, probably deriving from Aramaic, which was an important administrative language of the Middle East at that time. Kharoshthi, written from right to left, was supplanted by Brahmi and its derivatives. The descendants of Brahmi spread with myriad changes throughout the subcontinent and outlying islands. There are said to be some 200 different scripts deriving from it. By the eleventh century, the modern script known as Devanagari was in ascendancy in India proper as the major script of Sanskrit literature.

The North Indian branch of scripts was, like Brahmi itself, chiefly used to write Indo-European languages such as Pali and Sanskrit, and eventually the Hindi, Bangla, and Gujarati languages, though it was also the source for scripts for non-Indo-European languages such as Tibetan, Mongolian, and Lepcha.

The South Indian scripts are also derived from Brahmi and, therefore, share many structural characteristics. These scripts were first used to write Pali and Sanskrit but were later adapted for use in writing non-Indo-European languages—namely, the languages of the Dravidian family of southern India and Sri Lanka. Because of their use for Dravidian languages, the South Indian scripts developed many characteristics that distinguish them from the North Indian scripts. South Indian scripts were also exported to southeast Asia and were the source of scripts such as Tai Tham (Lanna) and Myanmar, as well as the insular scripts of the Philippines and Indonesia.

The shapes of letters in the South Indian scripts took on a quite distinct look from the shapes of letters in the North Indian scripts. Some scholars suggest that this occurred because writing materials such as palm leaves encouraged changes in the way letters were written.

The major official scripts of India proper, including Devanagari, are documented in this chapter. They are all encoded according to a common plan, so that comparable characters are in the same order and relative location. This structural arrangement, which facilitates transliteration to some degree, is based on the Indian national standard (ISCII) encoding for these scripts.

The first six columns in each script are isomorphic with the ISCII-1988 encoding, except that the last 11 positions (U+0955..U+095F in Devanagari, for example), which are unsigned or undefined in ISCII-1988, are used in the Unicode encoding. The seventh column in each of these scripts, along with the last 11 positions in the sixth column, represent additional character assignments in the Unicode Standard that are matched across some or all of the scripts. For example, positions U+xx66..U+xx6F and U+xxE6..U+xxEF code the Indic script digits for each script. The eighth column for each script is reserved for script-specific additions that do not correspond from one Indic script to the next.

While the arrangement of the encoding for the scripts of India is based on ISCII, this does not imply that the rendering behavior of South Indian scripts in particular is the same as that of Devanagari or other North Indian scripts. Implementations should ensure that adequate attention is given to the actual behavior of those scripts; they should not assume that they work just as Devanagari does. Each block description in this chapter describes the most important aspects of rendering for a particular script as well as unique behaviors it may have.

Many of the character names in this group of scripts represent the same sounds, and common naming conventions are used for the scripts of India.

12.1 Devanagari

Devanagari: U+0900–U+097F

The Devanagari script is used for writing classical Sanskrit and its modern historical derivative, Hindi. Extensions to the Sanskrit repertoire are used to write other related languages of India (such as Marathi) and of Nepal (Nepali). In addition, the Devanagari script is used to write the following languages: Awadhi, Bagheli, Bhatneri, Bhili, Bihari, Braj Bhasha, Chhattisgarhi, Garhwali, Gondi (Betul, Chhindwara, and Mandla dialects), Harauti, Ho, Jaipuri, Kachchhi, Kanauji, Konkani, Kului, Kumaoni, Kurku, Kurukh, Marwari, Mundari, Newari, Palpa, and Santali.

All other Indic scripts, as well as the Sinhala script of Sri Lanka, the Tibetan script, and the Southeast Asian scripts, are historically connected with the Devanagari script as descendants of the ancient Brahmi script. The entire family of scripts shares a large number of structural features.

The principles of the Indic scripts are covered in some detail in this introduction to the Devanagari script. The remaining introductions to the Indic scripts are abbreviated but highlight any differences from Devanagari where appropriate.

Standards. The Devanagari block of the Unicode Standard is based on ISCII-1988 (Indian Script Code for Information Interchange). The ISCII standard of 1988 differs from and is an update of earlier ISCII standards issued in 1983 and 1986.

The Unicode Standard encodes Devanagari characters in the same relative positions as those coded in positions A0–F4₁₆ in the ISCII-1988 standard. The same character code layout is followed for eight other Indic scripts in the Unicode Standard: Bengali/Bangla, Gurmukhi, Gujarati, Oriya, Tamil, Telugu, Kannada, and Malayalam. This parallel code layout emphasizes the structural similarities of the Brahmi scripts and follows the stated intention of the Indian coding standards to enable one-to-one mappings between analogous coding positions in different scripts in the family. Sinhala, Tibetan, Thai, Lao, Khmer, Myanmar, and other scripts depart to a greater extent from the Devanagari structural pattern, so the Unicode Standard does not attempt to provide any direct mappings for these scripts to the Devanagari order.

In November 1991, at the time *The Unicode Standard, Version 1.0*, was published, the Bureau of Indian Standards published a new version of ISCII in Indian Standard (IS) 13194:1991. This new version partially modified the layout and repertoire of the ISCII-1988 standard. Because of these events, the Unicode Standard does not precisely follow the layout of the current version of ISCII. Nevertheless, the Unicode Standard remains a superset of the ISCII-1991 repertoire. Modern, non-Vedic texts encoded with ISCII-1991 may be automatically converted to Unicode code points and back to their original encoding without loss of information. The Vedic extension characters defined in IS 13194:1991 *Annex G—Extended Character Set for Vedic* are now fully covered by the Unicode Standard, but the conversions between ISCII and Unicode code points in some cases are more complex than for modern texts.

Encoding Principles. The writing systems that employ Devanagari and other Indic scripts constitute *abugidas*—a cross between syllabic writing systems and alphabetic writing systems. The effective unit of these writing systems is the orthographic syllable, consisting of a consonant and vowel (CV) core and, optionally, one or more preceding consonants, with a canonical structure of (((C)C)V. The orthographic syllable need not correspond exactly with a phonological syllable, especially when a consonant cluster is involved, but the writing system is built on phonological principles and tends to correspond quite closely to pronunciation.

The orthographic syllable is built up of alphabetic pieces, the actual letters of the Devanagari script. These pieces consist of three distinct character types: consonant letters, independent vowels, and dependent vowel signs. In a text sequence, these characters are stored in logical (phonetic) order. Consonant letters by themselves constitute a CV unit, where the V is an *inherent* vowel, whose exact phonetic value may vary by writing system. Independent vowels also constitute a CV unit, where the C is considered to be null.

A dependent vowel sign is used to represent a V in CV units where C is not null and V is not the inherent vowel. CV units are not represented by sequences of a consonant followed by virama followed by independent vowel. In some cases, a phonological diphthong (such as Hindi जाओ /jāo/) is actually written as two orthographic CV units, where the second of these units is an independent vowel letter, whose C is considered to be null.

Principles of the Devanagari Script

Rendering Devanagari Characters. Devanagari characters, like characters from many other scripts, can combine or change shape depending on their context. A character's appearance is affected by its ordering with respect to other characters, the font used to render the character, and the application or system environment. These variables can cause the appearance of Devanagari characters to differ from their nominal glyphs (used in the code charts).

Additionally, a few Devanagari characters cause a change in the order of the displayed characters. This reordering is not commonly seen in non-Indic scripts and occurs independently of any bidirectional character reordering that might be required.

Consonant Letters. Each consonant letter represents a single consonantal sound but also has the peculiarity of having an *inherent vowel*, generally the short vowel /a/ in Devanagari and the other Indic scripts. Thus U+0915 DEVANAGARI LETTER KA represents not just /k/ but also /ka/. In the presence of a dependent vowel, however, the inherent vowel associated with a consonant letter is overridden by the dependent vowel.

Consonant letters may also be rendered as *half-forms*, which are presentation forms used within an orthographic syllable to depict initial consonants in a consonant cluster. These half-forms do not have an inherent vowel. Their rendered forms in Devanagari often resemble the full consonant but are missing the vertical stem, which marks a syllabic core. The stem glyph is graphically and historically related to the sign denoting the inherent /a/ vowel, as discussed later in this section.

Some Devanagari consonant letters have alternative presentation forms whose choice depends on neighboring consonants. This variability is especially notable for U+0930 DEVANAGARI LETTER RA, which has numerous different forms, both as the initial element and as the final element of a consonant cluster. Only the nominal forms, rather than the contextual alternatives, are depicted in the code charts.

The traditional Sanskrit/Devanagari alphabetic encoding order for consonants follows articulatory phonetic principles, starting with velar consonants and moving forward to bilabial consonants, followed by liquids and then fricatives. ISCII and the Unicode Standard both observe this traditional order.

Independent Vowel Letters. The independent vowels in Devanagari are letters that stand on their own. The writing system treats independent vowels as orthographic CV syllables in which the consonant is null. The independent vowel letters are used to write syllables that start with a vowel.

Dependent Vowel Signs (Matras). The dependent vowels serve as the common manner of writing noninherent vowels and are generally referred to as *vowel signs*, or as *matras* in Sanskrit. The dependent vowels do not stand alone; rather, they are visibly depicted in combination with a base letterform. A single consonant or a consonant cluster may have a dependent vowel applied to it to indicate the vowel quality of the syllable, when it is different from the inherent vowel. Explicit appearance of a dependent vowel in a syllable overrides the inherent vowel of a single consonant letter.

The greatest variation among different Indic scripts is found in the way that the dependent vowels are applied to base letterforms. Devanagari has a collection of nonspacing dependent vowel signs that may appear above or below a consonant letter, as well as spacing dependent vowel signs that may occur to the right or to the left of a consonant letter or consonant cluster. Other Indic scripts generally have one or more of these forms, but what is a nonspacing mark in one script may be a spacing mark in another. Also, some of the Indic scripts have single dependent vowels that are indicated by two or more glyph components—and those glyph components may *surround* a consonant letter both to the left and to the right or may occur both above and below it.

In modern usage the Devanagari script has only one character denoting a left-side dependent vowel sign: U+093F DEVANAGARI VOWEL SIGN I. In the historic Prishthamatra orthography, Devanagari also made use of one additional left-side dependent vowel sign: U+094E DEVANAGARI VOWEL SIGN PRISHTHAMATRA E. Other Indic scripts either have no such vowel signs (Telugu and Kannada) or include as many as three of these signs (Bengali/Bangla, Tamil, and Malayalam).

Vowel Letters. Vowel letters are encoded atomically in Unicode, even if they can be analyzed visually as consisting of multiple parts. *Table 12-1* shows vowel letters that can be analyzed, the single code point that should be used to represent them in text, and the sequence of code points resulting from analysis that should not be used.

Table 12-1. Devanagari Vowel Letters

For	Use	Do Not Use
ऐ	0904	<0905, 0946>
आ	0906	<0905, 093E>
ई	0908	<0930, 094D, 0907>
ऊ	090A	<0909, 0941>
ऎ	090D	<090F, 0945>
ऋ	090E	<090F, 0946>
ऌ	0910	<090F, 0947>
ऑ	0911	<0905, 0949> or <0906, 0945>
ओ	0912	<0905, 094A> or <0906, 0946>
औ	0913	<0905, 094B> or <0906, 0947>
औ	0914	<0905, 094C> or <0906, 0948>
अँ	0972	<0905, 0945>
अं	0973	<0905, 093A>
आँ	0974	<0905, 093B> or <0906, 093A>
औँ	0975	<0905, 094F>
अु	0976	<0905, 0956>
अु	0977	<0905, 0957>

Virama (Halant). Devanagari employs a sign known in Sanskrit as the *virama* or vowel omission sign. In Hindi, it is called *hal* or *halant*, and that term is used in referring to the virama or to a consonant with its vowel suppressed by the virama. The terms are used interchangeably in this section.

The virama sign, U+094D DEVANAGARI SIGN VIRAMA, nominally serves to cancel (or kill) the inherent vowel of the consonant to which it is applied. When a consonant has lost its inherent vowel by the application of virama, it is known as a *dead consonant*; in contrast, a *live consonant* is one that retains its inherent vowel or is written with an explicit dependent vowel sign. In the Unicode Standard, a dead consonant is defined as a sequence consisting of a consonant letter followed by a virama. The default rendering for a dead consonant is to position the virama as a combining mark bound to the consonant letterform.

For example, if C_n denotes the nominal form of consonant C, and C_d denotes the dead consonant form, then a dead consonant is encoded as shown in *Figure 12-1*.

Figure 12-1. Dead Consonants in Devanagari

$$TA_n + VIRAMA_n \rightarrow TA_d$$

$$त + ् \rightarrow त्$$

It could be assumed that a dead consonant may be combined with a vowel letter or sign to represent a CV orthographic syllable. Some non-Unicode implementations have used this approach; however, this is not done in implementations of the Unicode Standard. Instead, a CV orthographic syllable is represented with a (live) consonant followed by a dependent vowel. A dead consonant should not be followed either by an independent vowel letter or by a dependent vowel sign in an attempt to create an alternative representation of a CV orthographic syllable.

Atomic Representation of Consonant Letters. Consonant letters are encoded atomically in Unicode, even if they can be analyzed visually as consisting of multiple parts. In particular, consonant half forms are dead-consonant forms that often resemble a full consonant form minus a vertical stem. This vertical stem is visually similar to the vowel sign denoting /ā/, U+093E DEVANAGARI VOWEL SIGN AA. Table 12-2 shows atomic consonant letters in Devanagari that could be graphically analyzed this way, the single code point that should be used to represent them in text, and the sequence of code points resulting from analysis that should not be used.

Table 12-2. Devanagari Atomic Consonants

For	Use	Do Not Use
ख	0916	<0916, 094D, 093E>, <0916, 094D, 200D, 093E>
ग	0917	<0917, 094D, 093E>, <0917, 094D, 200D, 093E>
घ	0918	<0918, 094D, 093E>, <0918, 094D, 200D, 093E>
च	091A	<091A, 094D, 093E>, <091A, 094D, 200D, 093E>
ज	091C	<091C, 094D, 093E>, <091C, 094D, 200D, 093E>
झ	091D	<091D, 094D, 093E>, <091D, 094D, 200D, 093E>
ञ	091E	<091E, 094D, 093E>, <091E, 094D, 200D, 093E>
ण	0923	<0923, 094D, 093E>, <0923, 094D, 200D, 093E>
त	0924	<0924, 094D, 093E>, <0924, 094D, 200D, 093E>
थ	0925	<0925, 094D, 093E>, <0925, 094D, 200D, 093E>
ध	0927	<0927, 094D, 093E>, <0927, 094D, 200D, 093E>

Table 12-2. Devanagari Atomic Consonants (Continued)

For	Use	Do Not Use
न	0928	<0928, 094D, 093E>, <0928, 094D, 200D, 093E>
न	0929	<0929, 094D, 093E>, <0929, 094D, 200D, 093E>, <0928, 093C, 094D, 093E>, <0928, 093C, 094D, 200D, 093E>
प	092A	<092A, 094D, 093E>, <092A, 094D, 200D, 093E>
ब	092C	<092C, 094D, 093E>, <092C, 094D, 200D, 093E>
भ	092D	<092D, 094D, 093E>, <092D, 094D, 200D, 093E>
म	092E	<092E, 094D, 093E>, <092E, 094D, 200D, 093E>
य	092F	<092F, 094D, 093E>, <092F, 094D, 200D, 093E>
ल	0932	<0932, 094D, 093E>, <0932, 094D, 200D, 093E>
व	0935	<0935, 094D, 093E>, <0935, 094D, 200D, 093E>
श	0936	<0936, 094D, 093E>, <0936, 094D, 200D, 093E>
ष	0937	<0937, 094D, 093E>, <0937, 094D, 200D, 093E>
स	0938	<0938, 094D, 093E>, <0938, 094D, 200D, 093E>
ख	0959	<0959, 094D, 093E>, <0959, 094D, 200D, 093E>, <0916, 093C, 094D, 093E>, <0916, 093C, 094D, 200D, 093E>
ग	095A	<095A, 094D, 093E>, <095A, 094D, 200D, 093E>, <0917, 093C, 094D, 093E>, <0917, 093C, 094D, 200D, 093E>
ज़	095B	<095B, 094D, 093E>, <095B, 094D, 200D, 093E>, <091C, 093C, 094D, 093E>, <091C, 093C, 094D, 200D, 093E>
य़	095F	<095F, 094D, 093E>, <095F, 094D, 200D, 093E>, <092F, 093C, 094D, 093E>, <092F, 093C, 094D, 200D, 093E>
ज़़	0979	<0979, 094D, 093E>, <0979, 094D, 200D, 093E>
ष़	097A	<097A, 094D, 093E>, <097A, 094D, 200D, 093E>
ग़	097B	<097B, 094D, 093E>, <097B, 094D, 200D, 093E>
ज़़	097C	<097C, 094D, 093E>, <097C, 094D, 200D, 093E>
ड़	097E	<097E, 094D, 093E>, <097E, 094D, 200D, 093E>
ब़	097F	<097F, 094D, 093E>, <097F, 094D, 200D, 093E>

The practice of using atomic consonants to represent letters is recommended. Using a half-form plus stems should be avoided.

Consonant Conjuncts. The Indic scripts are noted for a large number of consonant conjunct forms that serve as orthographic abbreviations (ligatures) of two or more adjacent letterforms. This abbreviation takes place only in the context of a *consonant cluster*. An orthographic consonant cluster is defined as a sequence of characters that represents one or more dead consonants (denoted C_d) followed by a normal, live consonant letter (denoted C_l).

Under normal circumstances, a consonant cluster is depicted with a conjunct glyph if such a glyph is available in the current font. In the absence of a conjunct glyph, the one or more dead consonants that form part of the cluster are depicted using half-form glyphs. In the absence of half-form glyphs, the dead consonants are depicted using the nominal consonant forms combined with visible virama signs (see *Figure 12-2*).

Figure 12-2. Conjunct Formations in Devanagari

- | | |
|---------------------------------------------|-----------------------------------------------|
| (1) $GA_d + DHA_l \rightarrow GA_h + DHA_n$ | (3) $KA_d + SSA_l \rightarrow K.SSA_n$ |
| ग् + ध → र्ध | क् + ष → क्ष |
| (2) $KA_d + KA_l \rightarrow K.KA_n$ | (4) $RA_d + KA_l \rightarrow KA_l + RA_{sup}$ |
| क् + क → क्क | र् + क → र्क |

A number of types of conjunct formations appear in these examples: (1) a half-form of GA in its combination with the full form of DHA; (2) a vertical conjunct K.KA; and (3) a fully ligated conjunct K.SSA, in which the components are no longer distinct. In example (4) in *Figure 12-2*, the dead consonant RA_d is depicted with the nonspacing combining mark RA_{sup} (*repha*).

A consonant conjunct form can take a virama and so become a dead consonant conjunct form. A dead consonant conjunct form can be followed by another consonant letter, and so form a multi-consonant conjunct. For example, *Figure 12-3* illustrates a three-consonant conjunct form, P.S.YA.

Figure 12-3. Multi-Consonant Conjuncts in Devanagari

$$PA_d + SA_d + YA_l \rightarrow P.S.YA_n$$

$$प् + स् + य \rightarrow प्स्य$$

A well-designed Indic script font may contain hundreds of conjunct glyphs, but they are not encoded as Unicode characters because they are the result of ligation of distinct letters.

Indic script rendering software must be able to map appropriate combinations of characters in context to the appropriate conjunct glyphs in fonts.

A dead consonant conjunct may have an appearance like a half form, because the vertical stem of the last consonant is removed. As a result, a live consonant conjunct could be analyzed visually as consisting of the dead, consonant-conjunct half form plus the vowel sign /ā/. As in the case of consonant letters, the live form should not be represented using a half form followed by U+093E DEVANAGARI VOWEL SIGN AA. *Table 12-3* shows some examples of live consonant conjuncts that exhibit this visual pattern, but that should not be represented with fully analyzed sequences. *Table 12-3* also shows the sequence of code points that should be used to represent these conjuncts in text, and the sequence of code points resulting from analysis that should not be used.

Table 12-3. Devanagari Consonant Conjuncts

For	Use	Do Not Use
क्व	<0915, 094D, 091A>	<0915, 094D, 091A, 094D, 093E>, <0915, 094D, 091A, 094D, 200D, 093E>
क्ष	<0915, 094D, 0937>	<0915, 094D, 0937, 094D, 093E>, <0915, 094D, 0937, 094D, 200D, 093E>
त्त	<0924, 094D, 0924>	<0924, 094D, 0924, 094D, 093E>, <0924, 094D, 0924, 094D, 200D, 093E>
न्त	<0928, 094D, 0924>	<0928, 094D, 0924, 094D, 093E>, <0928, 094D, 0924, 094D, 200D, 093E>

Note that these are illustrative examples only. There are many consonant conjuncts that could be visually analyzed in the same way, and the same principle applies to all such cases: these should not be represented as dead conjunct plus vowel sign sequences. The practice of using atomic consonants to represent letters is recommended. Using a half-form plus stems should be avoided.

Explicit Virama (Halant). Normally a virama character serves to create dead consonants that are, in turn, combined with subsequent consonants to form conjuncts. This behavior usually results in a virama sign not being depicted visually. Occasionally, this default behavior is not desired when a dead consonant should be excluded from conjunct formation, in which case the virama sign is visibly rendered. To accomplish this goal, the Unicode Standard adopts the convention of placing the character U+200C ZERO WIDTH NON-JOINER immediately after the encoded dead consonant that is to be excluded from conjunct formation. In this case, the virama sign is always depicted as appropriate for the consonant to which it is attached.

For example, in *Figure 12-4*, the use of ZERO WIDTH NON-JOINER prevents the default formation of the conjunct form क्ष (K.SSA_n).

Explicit Half-Consonants. When a dead consonant participates in forming a conjunct, the dead consonant form is often absorbed into the conjunct form, such that it is no longer distinctly visible. In other contexts, the dead consonant may remain visible as a *half-consonant*

Figure 12-4. Preventing Conjunct Forms in Devanagari

$$KA_d + ZWNJ + SSA_l \rightarrow KA_d + SSA_n$$

$$क् + \boxed{ZW} + ष \rightarrow क्ष$$

form. In general, a half-consonant form is distinguished from the nominal consonant form by the loss of its inherent vowel stem, a vertical stem appearing to the right side of the consonant form. In other cases, the vertical stem remains but some part of its right-side geometry is missing.

In certain cases, it is desirable to prevent a dead consonant from assuming full conjunct formation yet still not appear with an explicit virama. In these cases, the half-form of the consonant is used. To explicitly encode a half-consonant form, the Unicode Standard adopts the convention of placing the character U+200D ZERO WIDTH JOINER immediately after the encoded dead consonant. The ZERO WIDTH JOINER denotes a nonvisible letter that presents linking or cursive joining behavior on either side (that is, to the previous or following letter). Therefore, in the present context, the ZERO WIDTH JOINER may be considered to present a context to which a preceding dead consonant may join so as to create the half-form of the consonant.

For example, if C_h denotes the half-form glyph of consonant C, then a half-consonant form is represented as shown in *Figure 12-5*.

Figure 12-5. Half-Consonants in Devanagari

$$KA_d + ZWJ + SSA_l \rightarrow KA_h + SSA_n$$

$$क् + \boxed{ZW} + ष \rightarrow क्ष$$

In the absence of the ZERO WIDTH JOINER, the sequence in *Figure 12-5* would normally produce the full conjunct form क्ष (K.SSA_n).

This encoding of half-consonant forms also applies in the absence of a base letterform. That is, this technique may be used to encode independent half-forms, as shown in *Figure 12-6*.

Figure 12-6. Independent Half-Forms in Devanagari

$$GA_d + ZWJ \rightarrow GA_h$$

$$ग् + \boxed{ZWJ} \rightarrow ग्$$

Other Indic scripts have similar half-forms for the initial consonants of a conjunct. Some, such as Oriya, also have similar half-forms for the final consonants; those are represented as shown in *Figure 12-7*.

Figure 12-7. Half-Consonants in Oriya

$$KA_n + ZWJ + VIRAMA + TA_l \rightarrow KA_l + TA_h$$

In the absence of the ZERO WIDTH JOINER, the sequence in *Figure 12-7* would normally produce the full conjunct form କଟ (K.TA_n).

Consonant Forms. In summary, each consonant may be encoded such that it denotes a live consonant, a dead consonant that may be absorbed into a conjunct, the half-form of a dead consonant, or a dead consonant with an overt halant that does not get absorbed into a conjunct (see *Figure 12-8*).

Figure 12-8. Consonant Forms in Devanagari and Oriya

क + ष	→ कष	KA _l + SSA _n
क + ◌̣ + ष	→ क्ष	K.SSA _n
क + ◌̣ + ZWJ + ष	→ क्ष	KA _h + SSA _n
क + ◌̣ + ZWNJ + ष	→ क्ष̣	KA _d + SSA _n
କ + ◌̣ + ଟ	→ କଟ	K.TA _n
କ + ZWJ + ◌̣ + ଟ	→ କଟ	KA _n + TA _h
କ + ◌̣ + ZWNJ + ଟ	→ କଟ	KA _d + TA _n

As the rendering of conjuncts and half-forms depends on the availability of glyphs in the font, the following fallback strategy should be employed:

- If the coded character sequence would normally render with a full conjunct, but such a conjunct is not available, the fallback rendering is to use half-forms. If those are not available, the fallback rendering should use an explicit (visible) virama.
- If the coded character sequence would normally render with a half-form (it contains a ZWJ), but half-forms are not available, the fallback rendering should use an explicit (visible) virama.

Rendering Devanagari

Rules for Rendering. This section provides more formal and detailed rules for minimal rendering of Devanagari as part of a plain text sequence. It describes the mapping between Unicode characters and the glyphs in a Devanagari font. It also describes the combining and ordering of those glyphs.

These rules provide minimal requirements for legibly rendering interchanged Devanagari text. As with any script, a more complex procedure can add rendering characteristics, depending on the font and application.

In a font that is capable of rendering Devanagari, the number of glyphs is greater than the number of Devanagari characters.

Notation. In the next set of rules, the following notation applies:

C_n	Nominal glyph form of consonant C as it appears in the code charts.
C_l	A live consonant, depicted identically to C_n .
C_d	Glyph depicting the dead consonant form of consonant C.
C_h	Glyph depicting the half-consonant form of consonant C.
L_n	Nominal glyph form of a conjunct ligature consisting of two or more component consonants. A conjunct ligature composed of two consonants X and Y is also denoted $X.Y_n$.
RA_{sup}	A nonspacing combining mark glyph form of U+0930 DEVANAGARI LETTER RA positioned above or attached to the upper part of a base glyph form. This form is also known as <i>repha</i> .
RA_{sub}	A nonspacing combining mark glyph form of U+0930 DEVANAGARI LETTER RA positioned below or attached to the lower part of a base glyph form.
V_{vs}	Glyph depicting the dependent vowel sign form of a vowel V.
$VIRAMA_n$	The nominal glyph form of the nonspacing combining mark depicting U+094D DEVANAGARI SIGN VIRAMA.

A virama character is not always depicted. When it is depicted, it adopts this nonspacing mark form.

Dead Consonant Rule. The following rule logically precedes the application of any other rule to form a dead consonant. Once formed, a dead consonant may be subject to other rules described next.

- R1** When a consonant C_n precedes a VIRAMA $_n$, it is considered to be a dead consonant C_d . A consonant C_n that does not precede VIRAMA $_n$ is considered to be a live consonant C_l .

$$TA_n + VIRAMA_n \rightarrow TA_d$$

$$त + ः \rightarrow त्$$

Consonant RA Rules. The character U+0930 DEVANAGARI LETTER RA takes one of a number of visual forms depending on its context in a consonant cluster. By default, this letter is depicted with its nominal glyph form (as shown in the code charts). In some contexts, it is depicted using one of two nonspacing glyph forms that combine with a base letterform.

- R2** If the dead consonant RA_d precedes a consonant, then it is replaced by the superscript nonspacing mark RA_{sup} , which is positioned so that it applies to the logically subsequent element in the memory representation.

$$RA_d + KA_l \rightarrow KA_l + RA_{sup} \quad \text{Displayed Output}$$

$$\underline{र} + क \rightarrow क + \overset{\circ}{र} \rightarrow \overset{\circ}{क}$$

$$RA_d^1 + RA_d^2 \rightarrow RA_d^2 + RA_{sup}^1$$

$$\underline{र} + \underline{र} \rightarrow \underline{र} + \overset{\circ}{र} \rightarrow \overset{\circ}{\underline{र}}$$

- R3** If the superscript mark RA_{sup} is to be applied to a dead consonant and that dead consonant is combined with another consonant to form a conjunct ligature, then the mark is positioned so that it applies to the conjunct ligature form as a whole.

$$RA_d + JA_d + NYA_l \rightarrow J.NYA_n + RA_{sup} \quad \text{Displayed Output}$$

$$\underline{र} + \underline{ज} + \underline{ञ} \rightarrow \underline{ज्ञ} + \overset{\circ}{र} \rightarrow \overset{\circ}{\underline{ज्ञ}}$$

- R4** If the superscript mark RA_{sup} is to be applied to a dead consonant that is subsequently replaced by its half-consonant form, then the mark is positioned so that it applies to the form that serves as the base of the consonant cluster.

$$RA_d + GA_d + GHA_l \rightarrow GA_h + GHA_l + RA_{sup} \quad \text{Displayed Output}$$

$$\underline{र} + \underline{ग} + \underline{घ} \rightarrow \underline{र} + \underline{घ} + \overset{\circ}{र} \rightarrow \overset{\circ}{\underline{रघ}}$$

R5 In conformance with the ISCII standard, the half-consonant form RRA_h is represented as eyelash-RA. This form of RA is commonly used in writing Marathi and Newari.

$$RRA_n + VIRAMA_n \rightarrow RRA_h$$

$$\underset{\sim}{र} + \overset{\circ}{\underset{\sim}{र}} \rightarrow \overset{\sim}{र}$$

R5a For compatibility with The Unicode Standard, Version 2.0, if the dead consonant RA_d precedes ZERO WIDTH JOINER, then the half-consonant form RA_h , depicted as eyelash-RA, is used instead of RA_{sup} .

$$RA_d + ZWJ \rightarrow RA_h$$

$$\underset{\sim}{र} + \boxed{\text{zwj}} \rightarrow \overset{\sim}{र}$$

R6 Except for the dead consonant RA_d , when a dead consonant C_d precedes the live consonant RA_l , then C_d is replaced with its nominal form C_n , and RA is replaced by the subscript nonspacing mark RA_{sub} , which is positioned so that it applies to C_n .

$$TTHA_d + RA_l \rightarrow TTHA_n + RA_{sub} \quad \text{Displayed Output}$$

$$\overset{\sim}{ठ} + र \rightarrow ठ + \overset{\circ}{\underset{\sim}{र}} \rightarrow \overset{\sim}{ठ}$$

R7 For certain consonants, the mark RA_{sub} may graphically combine with the consonant to form a conjunct ligature form. These combinations, such as the one shown here, are further addressed by the ligature rules described shortly.

$$PHA_d + RA_l \rightarrow PHA_n + RA_{sub} \quad \text{Displayed Output}$$

$$\overset{\sim}{फ} + र \rightarrow फ + \overset{\circ}{\underset{\sim}{र}} \rightarrow \overset{\sim}{फ}$$

R8 If a dead consonant (other than RA_d) precedes RA_d , then the substitution of RA for RA_{sub} is performed as described above; however, the VIRAMA that formed RA_d remains so as to form a dead consonant conjunct form.

$$TA_d + RA_d \rightarrow TA_n + RA_{sub} + VIRAMA_n \rightarrow T.RA_d$$

$$\overset{\sim}{त} + \underset{\sim}{र} \rightarrow त + \overset{\circ}{\underset{\sim}{र}} + \overset{\circ}{\underset{\sim}{र}} \rightarrow \overset{\sim}{त}$$

A dead consonant conjunct form that contains an absorbed RA_d may subsequently combine to form a multipart conjunct form.

$$T.RA_d + YA_l \rightarrow T.R.YA_n$$

$$\text{त्र} + \text{य} \rightarrow \text{त्रय}$$

Modifier Mark Rules. In addition to vowel signs, three other types of combining marks may be applied to a component of an orthographic syllable or to the syllable as a whole: *nukta*, *bindus*, and *svaras* (such as U+0951 DEVANAGARI STRESS SIGN UDATTA and U+0952 DEVANAGARI STRESS SIGN ANUDATTA).

R9 *The nukta sign, which modifies a consonant form, is placed immediately after the consonant in the memory representation and is attached to that consonant in rendering. If the consonant represents a dead consonant, then NUKTA should precede VIRAMA in the memory representation.*

$$KA_n + NUKTA_n + VIRAMA_n \rightarrow QA_d$$

$$\text{क} + \text{्} + \text{्} \rightarrow \text{क्}$$

R10 *Other modifying marks, in particular bindus and svaras, apply to the orthographic syllable as a whole and should follow (in the memory representation) all other characters that constitute the syllable. The bindus should follow any vowel signs, and the svaras should come last. The relative placement of these marks is horizontal rather than vertical; the horizontal rendering order may vary according to typographic concerns.*

$$KA_n + AA_{vs} + CANDRABINDU_n$$

$$\text{क} + \text{ा} + \text{ँ} \rightarrow \text{काँ}$$

Ligature Rules. Subsequent to the application of the rules just described, a set of rules governing ligature formation apply. The precise application of these rules depends on the availability of glyphs in the current font being used to display the text.

R11 *If a dead consonant immediately precedes another dead consonant or a live consonant, then the first dead consonant may join the subsequent element to form a two-part conjunct ligature form.*

$$JA_d + NYA_l \rightarrow J.NYA_n$$

$$TTA_d + TTHA_l \rightarrow TT.TTHA_n$$

$$\text{ज्} + \text{ज} \rightarrow \text{ज्ञ}$$

$$\text{ट्} + \text{ठ} \rightarrow \text{ट्ठ}$$

R12 A conjunct ligature form can itself behave as a dead consonant and enter into further, more complex ligatures.

$$SA_d + TA_d + RA_n \rightarrow SA_d + T.RA_n \rightarrow S.T.RA_n$$

$$\text{स्} + \text{त्} + \text{र} \rightarrow \text{स्} + \text{त्र} \rightarrow \text{स्त्र}$$

A conjunct ligature form can also produce a half-form.

$$K.SSA_d + YA_l \rightarrow K.SS_h + YA_n$$

$$\text{क्ष} + \text{य} \rightarrow \text{क्ष्य}$$

R13 If a nominal consonant or conjunct ligature form precedes RA_{sub} as a result of the application of rule R6, then the consonant or ligature form may join with RA_{sub} to form a multipart conjunct ligature (see rule R6 for more information).

$$KA_n + RA_{sub} \rightarrow K.RA_n$$

$$PHA_n + RA_{sub} \rightarrow PH.RA_n$$

$$\text{क} + \text{्र} \rightarrow \text{क्र}$$

$$\text{फ} + \text{्र} \rightarrow \text{फ्र}$$

R14 In some cases, other combining marks will combine with a base consonant, either attaching at a nonstandard location or changing shape. In minimal rendering, there are only two cases: RA_l with U_{vs} or UU_{vs} .

$$RA_l + U_{vs} \rightarrow RU_n$$

$$RA_l + UU_{vs} \rightarrow RUU_n$$

$$\text{र} + \text{ु} \rightarrow \text{रु}$$

$$\text{र} + \text{ू} \rightarrow \text{रू}$$

Memory Representation and Rendering Order. The storage of plain text in Devanagari and all other Indic scripts generally follows phonetic order; that is, a CV syllable with a dependent vowel is always encoded as a consonant letter C followed by a vowel sign V in the memory representation. This order is employed by the ISCII standard and corresponds to both the phonetic order and the keying order of textual data (see Figure 12-9).

Figure 12-9. Rendering Order in Devanagari

Character Order

Glyph Order

$$KA_n + I_{vs} \rightarrow I + KA_n$$

$$\text{क} + \text{ि} \rightarrow \text{कि}$$

Because Devanagari and other Indic scripts have some dependent vowels that must be depicted to the left side of their consonant letter, the software that renders the Indic scripts must be able to reorder elements in mapping from the logical (character) store to the presentational (glyph) rendering. For example, if C_n denotes the nominal form of consonant C , and V_{vs} denotes a left-side dependent vowel sign form of vowel V , then a reordering of glyphs with respect to encoded characters occurs as just shown.

R15 *When the dependent vowel l_{vs} is used to override the inherent vowel of a syllable, it is always written to the extreme left of the orthographic syllable. If the orthographic syllable contains a consonant cluster, then this vowel is always depicted to the left of that cluster.*

$$TA_d + RA_l + l_{vs} \rightarrow T.RA_n + l_{vs} \rightarrow l_{vs} + T.RA_d$$

$$त् + र + ि \rightarrow त्र + ि \rightarrow त्रि$$

R16 *The presence of an explicit virama (either caused by a ZWNJ or by the absence of a conjunct in the font) blocks this reordering, and the dependent vowel l_{vs} is rendered after the rightmost such explicit virama.*

$$TA_d + ZWNJ + RA_l + l_{vs} \rightarrow TA_d + l_{vs} + RA_l$$

$$त् + \boxed{ZW} + र + ि \rightarrow त्रि$$

Alternative Forms of Cluster-Initial RA. In addition to *reph* (rule R2) and *eyelash* (rule R5a), a cluster-initial RA may also take its nominal form while the following consonant takes a reduced form. This behavior is required by languages that make a morphological distinction between “*reph* on YA” and “RA with reduced YA”, such as Braj Bhasha. To trigger this behavior, a ZWJ is placed immediately before the *virama* to request a reduced form of the following consonant, while preventing the formation of *reph*, as shown in the third example below.

$$र + ्र + य \rightarrow र्य$$

$$र + ्र + \boxed{ZW} + य \rightarrow च्य$$

$$र + \boxed{ZW} + ्र + य \rightarrow र्य$$

Similar, special rendering behavior of cluster-initial RA is noted in other scripts of India. See, for example, “Interaction of Repha and Ya-phalaa” in *Section 12.2, Bengali (Bangla)*, “Reph” in *Section 12.7, Telugu*, and “Consonant Clusters Involving RA” in *Section 12.8, Kannada*.

Sample Half-Forms. Table 12-4 shows examples of half-consonant forms that are commonly used with the Devanagari script. These forms are glyphs, not characters. They may be encoded explicitly using ZERO WIDTH JOINER as shown. In normal conjunct formation, they may be used spontaneously to depict a dead consonant in combination with subsequent consonant forms.

Table 12-4. Sample Devanagari Half-Forms

क + ् + $\boxed{\text{ZW}}_{\text{J}}$ → क्	न + ् + $\boxed{\text{ZW}}_{\text{J}}$ → न्
ख + ् + $\boxed{\text{ZW}}_{\text{J}}$ → ख्	प + ् + $\boxed{\text{ZW}}_{\text{J}}$ → प्
ग + ् + $\boxed{\text{ZW}}_{\text{J}}$ → ग्	फ + ् + $\boxed{\text{ZW}}_{\text{J}}$ → फ्
घ + ् + $\boxed{\text{ZW}}_{\text{J}}$ → घ्	ब + ् + $\boxed{\text{ZW}}_{\text{J}}$ → ब्
च + ् + $\boxed{\text{ZW}}_{\text{J}}$ → च्	भ + ् + $\boxed{\text{ZW}}_{\text{J}}$ → भ्
ज + ् + $\boxed{\text{ZW}}_{\text{J}}$ → ज्	म + ् + $\boxed{\text{ZW}}_{\text{J}}$ → म्
झ + ् + $\boxed{\text{ZW}}_{\text{J}}$ → झ्	य + ् + $\boxed{\text{ZW}}_{\text{J}}$ → य्
ञ + ् + $\boxed{\text{ZW}}_{\text{J}}$ → ञ्	ल + ् + $\boxed{\text{ZW}}_{\text{J}}$ → ल्
ण + ् + $\boxed{\text{ZW}}_{\text{J}}$ → ण्	व + ् + $\boxed{\text{ZW}}_{\text{J}}$ → व्
त + ् + $\boxed{\text{ZW}}_{\text{J}}$ → त्	श + ् + $\boxed{\text{ZW}}_{\text{J}}$ → श्
थ + ् + $\boxed{\text{ZW}}_{\text{J}}$ → थ्	ष + ् + $\boxed{\text{ZW}}_{\text{J}}$ → ष्
ध + ् + $\boxed{\text{ZW}}_{\text{J}}$ → ध्	स + ् + $\boxed{\text{ZW}}_{\text{J}}$ → स्

Sample Ligatures. Table 12-5 shows examples of conjunct ligature forms that are commonly used with the Devanagari script. These forms are glyphs, not characters. Not every writing system that employs this script uses all of these forms; in particular, many of these forms are used only in writing Sanskrit texts. Furthermore, individual fonts may provide fewer or more ligature forms than are depicted here.

Table 12-5. Sample Devanagari Ligatures

क + ्र + क	→	क्क
क + ्र + त	→	क्त
क + ्र + र	→	क्र
क + ्र + ष	→	क्ष
ड + ्र + क	→	ड्क
ड + ्र + ख	→	ड्ख
ड + ्र + ग	→	ड्ग
ड + ्र + घ	→	ड्घ
ज + ्र + ज	→	ज्ज
ज + ्र + य	→	ज्य
द + ्र + घ	→	द्घ
द + ्र + द	→	द्द
द + ्र + ध	→	द्ध
द + ्र + ब	→	द्ब
द + ्र + भ	→	द्भ
द + ्र + म	→	द्म
द + ्र + य	→	द्य
द + ्र + व	→	द्व
ट + ्र + ट	→	ट्ट

ठ + ्र + ठ	→	ठ्ठ
ठ + ्र + ठ	→	ठ्ठ
ड + ्र + ग	→	ड्ग
ड + ्र + ड	→	ड्ड
ड + ्र + ढ	→	ड्ढ
त + ्र + त	→	त्त
त + ्र + र	→	त्र
न + ्र + न	→	न्न
फ + ्र + र	→	फ्र
श + ्र + र	→	श्र
ह + ्र + म	→	ह्म
ह + ्र + य	→	ह्य
ह + ्र + ल	→	ह्ल
ह + ्र + व	→	ह्व
ह + ्र	→	ह्र
र + ्र	→	र्र
र + ्र	→	र्र
स + ्र + त्र	→	स्त्र

Ligature Forms for Ra + Vocalic Liquids. The phonological sequence /r vocalic_r/, expressed with the character sequence <U+0930 ra, U+0943 vocalic_r>, can graphically appear as either of two forms, as shown in the first row of *Table 12-6*. It may appear as the full independent vowel form of the vocalic_r, with a superscript *repha* form of the ra (V + RA_{sup}): र्रे. Alternatively, it may appear as the full letter form of the ra with the subscript, dependent form of the vocalic_r (RA_n + V_{vs}): रृ. Similarly, the phonological sequences with the other vocalic sounds (*rr, l, ll*) have two written forms, as shown in *Table 12-6*.

Table 12-6. RA + Vocalic Letter Ligature Forms

र	+	ॠ	→	र्रे	or	रृ
र	+	ॡ	→	र्रे	or	रृ
र	+	ॢ	→	र्रे	or	रृ
र	+	ॣ	→	र्रे	or	रृ

The graphical forms displayed above with the reph (RA_{sup}) should not be represented by sequences of RA + virama + independent vowel, as such sequences violate the general encoding principles of the script. CV orthographic syllables are not represented by consonant + virama + independent vowel.

The practice of writing these phonological sequences as a *reph* on an independent vocalic liquid letter is also observed in other Indic scripts, such as Gujarati, Oriya, Telugu, Kannada, and Bhaiksuki.

Sample Half-Ligature Forms. In addition to half-form glyphs of individual consonants, half-forms are used to depict conjunct ligature forms. A sample of such forms is shown in *Table 12-7*. These forms are glyphs, not characters. They may be encoded explicitly using ZERO WIDTH JOINER as shown. In normal conjunct formation, they may be used spontaneously to depict a conjunct ligature in combination with subsequent consonant forms.

Table 12-7. Sample Devanagari Half-Ligature Forms

क	+	्	+	ष	+	्	+	ZWJ	→	क्ष
ज	+	्	+	ञ	+	्	+	ZWJ	→	ञ्ज
त	+	्	+	त	+	्	+	ZWJ	→	त्त
त	+	्	+	र	+	्	+	ZWJ	→	त्र
श	+	्	+	र	+	्	+	ZWJ	→	श्र

Language-Specific Allographs. In Marathi, Nepali, and some South Indian orthographies, variant glyphs are preferred for certain letters and digits. These include U+091D DEVANAGARI LETTER JHA, U+0932 DEVANAGARI LETTER LA, U+0936 DEVANAGARI LETTER SHA, and the digits five, eight, and nine, as shown in *Table 12-8*. Marathi also makes use of the “eyelash” form of the letter RA, as discussed in rule R5.

Table 12-8. Marathi and Nepali Allographs

Code Point	Hindi	Marathi	Nepali
U+091D JHA	झ	झ	भ्र
U+0932 LA	ल	ल	ल
U+0936 SHA	श	श	श
U+096B FIVE	५	५	५
U+096E EIGHT	८	८	८
U+096F NINE	९	९	९

In addition, various languages written in Devanagari (or sometimes their various orthographic traditions) tend to have different preferences for formation of certain ligatures (see the text on “Sample Ligatures,” earlier in this section). For example, modern Nepali orthographies prefer a smaller number of ligatures than commonly used in Hindi or Marathi.

Combining Marks. Devanagari and other Indic scripts have a number of combining marks that could be considered diacritic. One class of these marks, known as bindus, is represented by U+0901 DEVANAGARI SIGN CANDRABINDU and U+0902 DEVANAGARI SIGN ANUSVARA. These marks indicate nasalization or final nasal closure of a syllable. U+093C DEVANAGARI SIGN NUKTA is a true diacritic. It is used to extend the basic set of consonant letters by modifying them (with a subscript dot in Devanagari) to create new letters.

U+0951 DEVANAGARI STRESS SIGN UDATTA and U+0952 DEVANAGARI STRESS SIGN ANUDATTA are tone marks used in the representation of Vedic text in Devanagari. These two combining marks may also occur in the representation of Vedic texts written in other scripts, including transliterations in the Latin script. They are given the Indic_Syllabic_Category value of Cantillation_Mark.

U+0953 DEVANAGARI GRAVE ACCENT and U+0954 DEVANAGARI ACUTE ACCENT were originally encoded for Latin transliteration of Sanskrit text. However, such use is now discouraged, and Latin transliterations should simply use the generic combining marks, U+0300 COMBINING GRAVE ACCENT and U+0301 COMBINING ACUTE ACCENT. Because U+0953 and U+0954 are not intended to be used with the Devanagari script, they have no explicit property values for Indic_Positional_Category and Indic_Syllabic_Category.

Devanagari Digits, Punctuation, and Symbols

Digits. Each Indic script has a distinct set of digits appropriate to that script. These digits may or may not be used in ordinary text in that script. European digits have displaced the Indic script forms in modern usage in many of the scripts. Some Indic scripts—notably Tamil—lacked a distinct digit for zero in their traditional numerical systems, but adopted a zero based on general Indian practice.

Punctuation. U+0964 | DEVANAGARI DANDA is similar to a full stop. U+0965 || DEVANAGARI DOUBLE DANDA marks the end of a verse in traditional texts. The term *danda* is from Sanskrit, and the punctuation mark is generally referred to as a *viram* instead in Hindi. Although the *danda* and *double danda* are encoded in the Devanagari block, the intent is that they be used as common punctuation for all the major scripts of India covered by this chapter. *Danda* and *double danda* punctuation marks are not separately encoded for some Indic scripts, such as Gujarati, Gurmukhi, and Oriya. However, analogous punctuation marks for other Brahmi-derived scripts *are* separately encoded, particularly for scripts used primarily outside of India.

Many modern languages written in the Devanagari script intersperse punctuation derived from the Latin script. Thus U+002C COMMA and U+002E FULL STOP are freely used in writing Hindi, and the *danda* is usually restricted to more traditional texts. However, the *danda* may be preserved when such traditional texts are transliterated into the Latin script.

Other Symbols. U+0970 ° DEVANAGARI ABBREVIATION SIGN appears after letters or combinations of letters and marks the sequence as an abbreviation. It is intended specifically for Devanagari script-based abbreviations, such as the Devanagari rupee sign. Other symbols and signs most commonly occurring in Vedic texts are encoded in the Devanagari Extended and Vedic Extensions blocks and are discussed in the text that follows.

The *svasti* (or well-being) signs often associated with the Hindu, Buddhist, and Jain traditions are encoded in the Tibetan block. See *Section 13.4, Tibetan* for further information.

Extensions in the Main Devanagari Block

Sindhi Letters. The characters U+097B DEVANAGARI LETTER GGA, U+097C DEVANAGARI LETTER JJA, U+097E DEVANAGARI LETTER DDDA, and U+097F DEVANAGARI LETTER BBA are used to write Sindhi implosive consonants. Previous versions of the Unicode Standard recommended representing those characters as a combination of the usual consonants with *nukta* and *anudatta*, but those combinations are no longer recommended.

Konkani. Konkani makes use of additional sounds that can be represented with combinations such as U+091A DEVANAGARI LETTER CA plus U+093C DEVANAGARI SIGN NUKTA and U+091F DEVANAGARI LETTER TTA plus U+0949 DEVANAGARI VOWEL SIGN CANDRA O.

Kashmiri Letters. There are several letters for use with Kashmiri when written in Devanagari script. Long and short versions of the independent vowel letters are encoded in the range U+0973..U+0977. The corresponding dependent vowel signs are U+093A DEVANAGARI VOWEL SIGN OE, U+093B DEVANAGARI VOWEL SIGN OOE, and U+094F DEVANAGARI VOWEL SIGN AW. The forms of the independent vowels for Kashmiri are constructed by using the glyphs of the matras U+093B DEVANAGARI VOWEL SIGN OOE, U+094F DEVANAGARI VOWEL SIGN AW, U+0956 DEVANAGARI VOWEL SIGN UE, and U+0957 DEVANAGARI VOWEL SIGN UUE as diacritics on U+0905 DEVANAGARI LETTER A. However, for representation of independent vowels in Kashmiri, use the encoded, composite characters in the range U+0973..U+0977 and not the visually equivalent sequences of U+0905 DEVANAGARI LETTER A plus the matras. See *Table 12-1*. A few of the letters identified as being used for Kashmiri are also used to write the Bihari languages.

Bodo, Dogri, and Maithili. The orthographies of the Bodo, Dogri, and Maithili languages of India make use of U+02BC “ ’ ” MODIFIER LETTER APOSTROPHE, either as a tone mark or as a length mark. In Bodo and Dogri, this character functions as a tone mark, called *gojau kamaa* in Bodo and *sur chinha* in Dogri. In Dogri, the tone mark occurs after short vowels, including inherent vowels, and indicates a high-falling tone. After Dogri long vowels, a high-falling tone is written instead using U+0939 DEVANAGARI LETTER HA.

In Maithili, U+02BC “ ’ ” MODIFIER LETTER APOSTROPHE is used to indicate the prolongation of a short *a* and to indicate the truncation of words. This sign is called *bikari kaamaa*.

Examples illustrating the use of U+02BC “ ’ ” MODIFIER LETTER APOSTROPHE in Bodo, Dogri, and Maithili are shown in *Figure 12-10*. The Maithili examples show the same sentence, first in full form, and then using U+02BC to show truncation of words.

Figure 12-10. Use of Apostrophe in Bodo, Dogri and Maithili

Language	Examples	Meaning
Bodo	खर' दख'ना	head type of Bodo dress
Dogri	ख'ल्ल ति'लकना	down to slip
Maithili	कतए पड़ाए गेलह? कत' पड़ा' गेल'?	} Where did you go away?

In both Dogri and Maithili, an *avagraha sign*, U+093D DEVANAGARI SIGN AVAGRAHA, is used to indicate extra-long vowels. An example of the contrastive use of this *avagraha sign* is shown for Dogri in *Figure 12-11*.

Figure 12-11. Use of Avagraha in Dogri

Example	Meaning
तला	sole
तलाऽ	pond

Letters for Bihari Languages. A number of the Devanagari vowel letters have been used to write the Bihari languages Bhojpuri, Magadhi, and Maithili, as listed in *Table 12-9*.

Table 12-9. Devanagari Vowels Used in Bihari Languages

U+090E	DEVANAGARI LETTER SHORT E
U+0912	DEVANAGARI LETTER SHORT O
U+0946	DEVANAGARI VOWEL SIGN SHORT E
U+094A	DEVANAGARI VOWEL SIGN SHORT O
U+0973	DEVANAGARI LETTER OE
U+0974	DEVANAGARI LETTER OOE
U+0975	DEVANAGARI LETTER AW
U+093A	DEVANAGARI VOWEL SIGN OE
U+093B	DEVANAGARI VOWEL SIGN OOE
U+094F	DEVANAGARI VOWEL SIGN AW

Letter Short a. The character U+0904 DEVANAGARI LETTER SHORT A is used to denote a short *e* in the Awadi language, an Indo-Aryan language spoken in the north Indian state of Uttar Pradesh and southern Nepal. A publisher in Lucknow, Uttar Pradesh also uses it in Hindi translations and Devanagari transliterations of the Kannada, Telugu, Tamil, Malayalam and Kashmiri languages.

Prishthamatra Orthography. In the historic Prishthamatra orthography, the vowel signs for *e*, *ai*, *o*, and *au* are represented using U+094E DEVANAGARI VOWEL SIGN PRISHTHAMATRA E (which goes on the left side of the consonant) alone or in combination with one of U+0947 DEVANAGARI VOWEL SIGN E, U+093E DEVANAGARI VOWEL SIGN AA or U+094B DEVANAGARI VOWEL SIGN O. *Table 12-10* shows those combinations applied to *ka*. In the underlying representation of text, U+094E should be first in the sequence of dependent vowel signs after the consonant, and may be followed by U+0947, U+093E or U+094B.

Devanagari Extended: U+A8E0–U+A8FF

This block of characters is used chiefly for Vedic Sanskrit, although many of the characters are generic and can be used by other Indic scripts. The block includes a set of combining digits, letters, and *avagraha* which is used as a system of cantillation marks in the early

Table 12-10. Prishthamatra Orthography

	Prishthamatra Orthography	Modern Orthography
ke	क्के <0915, 094E>	के <0915, 0947>
kai	क्कै <0915, 094E, 0947>	कै <0915, 0948>
ko	क्का <0915, 094E, 093E>	को <0915, 094B>
kau	क्कौ <0915, 094E, 094B>	कौ <0915, 094C>

Vedic Sanskrit texts. The Devanagari Extended block also includes nasalization marks (*candrabindu*), and a number of editorial marks.

The Devanagari Extended block, as well as the Vedic Extensions block and the Devanagari block, include characters that are used to indicate tone in Vedic Sanskrit. Indian linguists describe tone as a feature of vowels, shared by the consonants in the same syllable, or as a feature of syllables. In Vedic, vowels are marked for tone, as are certain non-vocalic characters that are syllabified in Vedic recitation (*visarga* and *anusvāra*); the tone marks directly follow the vowel or other character that they modify. Vowels are categorized according to tone as either *udātta* (high-toned or “acute”), *anudātta* (low-toned or “non-acute”), *svarita* (“modulated” or dropping from high to low tone) or *ekasruti* (monotone). Some of the symbols used for marking tone indicate different tones in different traditions. *Visarga* may be marked for all three tones. The tone marks also can indicate other modifications of vocal text, such as vibration, lengthening a vowel, or skipping a tone in a descending scale.

Cantillation marks are used to indicate length, tone, and other features in the recited text of *Sāmaveda*, and in the Kauthuma and Rāṇyāniya traditions of *Sāmagāna*. These marks are encoded as a series of combining digits, alphabetic characters, and *avagraha* in the range U+A8E0..U+A8F1.

Cantillation Marks for the *Sāmaveda*. One of the four major Vedic texts is *Sāmaveda*. The text is both recited (*Sāmaveda-Saṁhitā*) and sung (*Sāmagāna*), and is marked differently for the purposes of each. Cantillation marks are used to indicate length, tone, and other features in the recited text of *Sāmaveda*, and in the Kauthuma and Rāṇyāniya traditions of *Sāmagāna*. These marks are encoded as a series of combining digits, alphabetic characters, and *avagraha* in the range U+A8E0..U+A8F1. The marks are rendered directly over the base letter. They are represented in text immediately after the syllable they modify.

In certain cases, two marks may occur over a letter: U+A8E3 COMBINING DEVANAGARI DIGIT THREE may be followed by U+A8EC COMBINING DEVANAGARI LETTER KA, for example. Although no use of U+A8E8 COMBINING DEVANAGARI DIGIT EIGHT has been found in the *Sāmagāna*, it is included to provide a complete set of 0–9 digits. The combining marks encoded for the *Sāmaveda* do not include characters that may appear as subscripts and superscripts in the Jaiminiya tradition of *Sāmagāna*, which used interlinear annotation. Interlinear annotation may be rendered using Ruby and may be represented by means of markup or other higher-level protocols.

Nasalization Marks. The set of spacing marks in the range U+A8F2..U+A8F7 include the term *candrabindu* in their names and indicate nasalization. These marks are all aligned with the headline. Note that U+A8F2 DEVANAGARI SIGN SPACING CANDRABINDU is lower than the U+0901 DEVANAGARI SIGN CANDRABINDU.

Editorial Marks. A set of editorial marks is encoded in the range U+A8F8..U+A8FB for use with Devanagari. U+A8F9 DEVANAGARI GAP FILLER signifies an intentional gap that would ordinarily be filled with text. In contrast, U+A8FB DEVANAGARI HEADSTROKE indicates illegible gaps in the original text. The glyph for DEVANAGARI HEADSTROKE should be designed so that it does not connect to the headstroke of the letters beside it, which will make it possible to indicate the number of illegible syllables in a given space. U+A8F8 DEVANAGARI SIGN PUSHPIKA acts as a filler in text, and is commonly flanked by double dandas. U+A8FA DEVANAGARI CARET, a zero-width spacing character, marks the insertion point of omitted text, and is placed at the insertion point between two orthographic syllables. It can also be used to indicate word division.

Vedic Extensions: U+1CD0–U+1CFF

The Vedic Extensions block includes characters that are used in Vedic texts; they may be used with Devanagari, as well as many other Indic scripts. This block includes a set of characters designating tone, grouped by the various Vedic traditions in which they occur. Characters indicating tone marks directly follow the character they modify. Most of these marks indicate the tone of vowels, but three of them specifically indicate the tone of *visarga*.

A number of marks for nasalization are also included in the block. U+1CD3 VEDIC SIGN NIHSHVASA is a breaking mark which separates sections of Samavedic singing between which a pause is disallowed. The block also contains several Vedic signs for *ardhavisarga*, *jihvamuliya*, *upadhmaniya* and *atikrama*.

Tone Marks. The Vedic tone marks are all combining marks. The tone marks are grouped together in the code charts based upon the tradition in which they appear: they are used in the four core texts of the Vedas (*Sāmaveda*, *Yajurveda*, *Rigveda*, and *Atharvaveda*) and in the prose text on Vedic ritual (*Śatapathabrāhmaṇa*). The character U+1CD8 VEDIC TONE CANDRA BELOW is also used to identify the short vowels *e* and *o*. In this usage, the prescribed order is the Indic syllable (*aksara*), followed by U+1CD8 VEDIC TONE CANDRA BELOW and the tone mark (*svara*). When a tone mark is placed below, it appears below the VEDIC TONE CANDRA BELOW.

In addition to the marks encoded in this block, Vedic texts may use other nonspacing marks from the General Diacritics block and other blocks. For example, U+20F0 COMBINING ASTERISK ABOVE would be used to represent a mark of that shape above a Vedic letter.

Diacritics for the Visarga. A set of combining marks that serve as diacritics for the *visarga* is encoded in the range U+1CE2..U+1CE8. These marks indicate that the *visarga* has a particular tone. For example, the combination U+0903 DEVANAGARI SIGN VISARGA plus U+1CE2 VEDIC SIGN VISARGA SVARITA represents a *svarita visarga*. The upward-shaped

diacritic is used for the *udātta* (high-toned), the downward-shaped diacritic for *anudātta* (low-toned), and the midline glyph indicates the *svārita* (modulated tone).

In Vedic manuscripts the tonal mark (that is, the horizontal bar, upward curve and downward curve) appears in colored ink, while the two dots of the *visarga* appear in black ink. The characters for accents can be represented using separate characters, to make it easier for color information to be maintained by means of markup or other higher-level protocols.

Nasalization Marks. A set of spacing marks and one combining mark, U+1CED VEDIC SIGN TIRYAK, are encoded in the range U+1CE9..U+1CF1. They describe phonetic distinctions in the articulation of nasals. The *gomukha* characters from U+1CE9..U+1CEC may be combined with U+0902 DEVANAGARI SIGN ANUSVARA or U+0901 DEVANAGARI SIGN CANDRABINDU. U+1CF1 VEDIC SIGN ANUSVARA UBHAYATO MUKHA may indicate a *visarga* with a tonal mark as well as a nasal. The three characters, U+1CEE VEDIC SIGN HEXIFORM LONG ANUSVARA, U+1CEF VEDIC SIGN LONG ANUSVARA, and U+1CF0 VEDIC SIGN RTHANG LONG ANUSVARA, are all synonymous and indicate a long *anuvāra* after a short vowel. U+1CED VEDIC SIGN TIRYAK is the only combining character in this set of nasalization marks. While it appears similar to the U+094D DEVANAGARI SIGN VIRAMA, it is used to render glyph variants of nasal marks that occur in manuscripts and printed texts.

Ardhavisarga. U+1CF2 VEDIC SIGN ARDHAVISARGA is a character that marks either the *jihvāmūliya*, a velar fricative occurring only before the unvoiced velar stops *ka* and *kha*, or the *upadhmaniya*, a bilabial fricative occurring only before the unvoiced labial stops *pa* and *pha*. *Ardhavisarga* is a spacing character. It is represented in text in visual order before the consonant it modifies.

12.2 Bengali (Bangla)

Bengali: U+0980–U+09FF

The term *Bengali* is used in the Unicode Standard for the script and character names. However, users of the script in the Indian state of West Bengal and the People’s Republic of Bangladesh prefer *Bangla*, so the term *Bangla* is used in this section and elsewhere in this chapter. The Bangla script is used for writing languages such as Bangla, Assamese, Bishnupriya Manipuri, Daphla, Garo, Hallam, Khasi, Mizo, Munda, Naga, Rian, and Santali. Although the Assamese language has been written historically using regional scripts, known generally as “Kamrupi,” its modern writing system is similar to that presently used for Bangla, with the addition of extra characters. The Bangla block supports the modern Assamese orthography. In the Indian state of Assam, the script is called *Asamiya* or *Assamese*.

The Bangla script is a North Indian script historically related to Devanagari.

Virama (Hasant). The Bangla script uses the Unicode virama model to form conjunct consonants. In Bangla, the virama is known as *hasant*.

Vowel Letters. Vowel letters of Indic scripts are encoded atomically in Unicode, even if they can be analyzed visually as consisting of multiple parts. *Table 12-11* shows the Bangla vowel letters that can be analyzed, the single code point that should be used to represent them in text, and the sequence of code points resulting from analysis that should not be used.

Table 12-11. Bangla Vowel Letters

For	Use	Do Not Use
ঐ	0986	<0985, 09BE>
ঋ	09E0	<098B, 09C3>
৐	09E1	<098C, 09E2>

There is an exception to this general pattern for the representation of Bangla independent vowel letters, for the Bangla script orthography of Kokborok, a major language of Tripura state in Northeast India. Kokborok has diphthongs which can occur as initial letters. To reflect existing practice, these diphthongs are represented with two character sequences, rather than as atomic characters, as shown in *Table 12-12*. Rendering systems which support display of the Kokborok orthography need to be aware of these exceptional sequences. The sequence for *vowel letter aw* uses U+09D7 BENGALI AU LENGTH MARK, also noted in the following discussion of two-part vowel signs.

Two-Part Vowel Signs. The Bangla script, along with a number of other Indic scripts, makes use of two-part dependent vowel signs. In these dependent vowels (*matras*) one-half of the vowel is displayed on each side of a consonant letter or cluster—for example, U+09CB BENGALI VOWEL SIGN O and U+09CC BENGALI VOWEL SIGN AU. To provide com-

Table 12-12. Diphthong Vowel Letters in Kokborok

For	Use	Description
ঔ	<0985, 09D7>	vowel letter <i>aw</i>
ঊ	<0989, 09BE>	vowel letter <i>ua</i>

patibility with existing implementations of the scripts that use two-part vowel signs, the Unicode Standard explicitly encodes the right half of these vowel signs. For example, U+09D7 BENGALI AU LENGTH MARK represents the right-half glyph component of U+09CC BENGALI VOWEL SIGN AU. In Bangla orthography, the *au length mark* is always used in conjunction with the left part and does not have a meaning on its own.

Special Characters. U+09F2..U+09F9 are a series of Bangla additions for writing currency and fractions.

Historic Characters. The characters *vocalic rr*, *vocalic l* and *vocalic ll*, both in their independent and dependent forms (U+098C, U+09C4, U+09E0..U+09E3), are only used to write Sanskrit words in the Bangla script.

Characters for Assamese. Assamese employs two letters not used for the Bangla language. The Assamese letter *ra* is represented in Unicode by U+09F0 ঞ BENGALI LETTER RA WITH MIDDLE DIAGONAL, and the Assamese letter *wa* is represented by U+09F1 ঞ BENGALI LETTER RA WITH LOWER DIAGONAL.

Assamese uses a conjunct character called *kssa*. Although *kssa* is often considered a separate letter of the alphabet, it is not separately encoded. The conjunct is represented by the sequence <U+0995 ক BENGALI LETTER KA, U+09CD ্ BENGALI SIGN VIRAMA, U+09B7 ষ BENGALI LETTER SSA>. This same sequence is also used to represent the Bangla letter *khinya* (or *khiya*).

Assamese uses two additional consonant-vowel ligatures formed with U+09F0 BENGALI LETTER RA WITH MIDDLE DIAGONAL, which are not used for the Bangla language. These consonant-vowel ligatures are shown in the “ligated” column in Table 12-13.

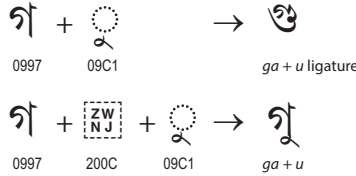
Table 12-13. Assamese Consonant-Vowel Combinations

	Code Points	Ligated	Non-ligated
<i>ru</i>	<09F0, 09C1>	ৰু	ৰু
<i>rū</i>	<09F0, 09C2>	ৰী	ৰী

Rendering Behavior. Like other Brahmic scripts in the Unicode Standard, Bangla uses the *hasant* to form conjunct characters. For example, U+09B8 স BENGALI LETTER SA + U+09CD ্ BENGALI SIGN VIRAMA + U+0995 ক BENGALI LETTER KA yields the conjunct স্কা. For general principles regarding the rendering of the Bangla script, see the rules for rendering in Section 12.1, *Devanagari*.

If the ligated form is the default for a given font implementation, then ZWNJ can be inserted to block a ligature, as shown in *Figure 12-13*.

Figure 12-13. Blocking Bangla Consonant-Vowel Ligature



Khya. The letter ঙ্, known as *khiya* or *khinya*, is often considered as a distinct letter of the Bangla alphabet. However, it is not encoded separately. It is represented by the sequence <U+0995 ঙ BENGALI LETTER KA, U+09CD ◌্ BENGALI SIGN VIRAMA, U+09B7 ঙ BENGALI LETTER SSA>.

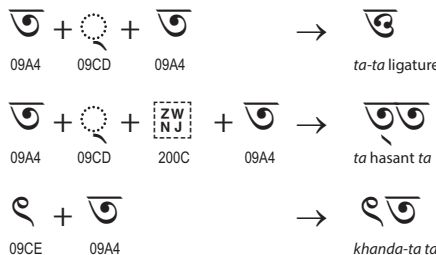
Khanda Ta. In Bangla, a dead consonant *ta* makes use of a special form, U+09CE BENGALI LETTER KHANDA TA. This form is used in all contexts except where it is immediately followed by one of the consonants: *ta*, *tha*, *na*, *ba*, *ma*, *ya*, or *ra*.

Khanda ta cannot bear a vowel matra or combine with a following consonant to form a conjunct *aksara*. It can form a conjunct *aksara* only with a preceding dead consonant *ra*, with the latter being displayed with a *repha* glyph placed on the *khanda ta*.

Versions of the Unicode Standard prior to Version 4.1 recommended that *khanda ta* be represented as the sequence <U+09A4 BENGALI LETTER TA, U+09CD BENGALI SIGN VIRAMA, U+200D ZERO WIDTH JOINER> in all circumstances. U+09CE BENGALI LETTER KHANDA TA should instead be used explicitly in newly generated text, but users are cautioned that instances of the older representation may exist.

The Bangla syllable *tta* illustrates the usage of *khanda ta* when followed by *ta*. The syllable *tta* is normally represented with the sequence <U+09A4 *ta*, U+09CD *hasant*, U+09A4 *ta*>. That sequence will normally be displayed using a single glyph *tta* ligature, as shown in the first example in *Figure 12-14*.

Figure 12-14. Bangla Syllable *tta*



It is also possible for the sequence <ta, hasant, ta> to be displayed with a full ta glyph combined with a hasant glyph, followed by another full ta glyph ত্ত. The choice of form actually displayed depends on the display engine, based on the availability of glyphs in the font.

The Unicode Standard also provides an explicit way to show the hasant glyph. To do so, a ZERO WIDTH NON-JOINER is inserted after the hasant. That sequence is always displayed with the explicit hasant, as shown in the second example in Figure 12-14.

When the syllable tta is written with a khanda ta, however, the character U+09CE BENGALI LETTER KHANDA TA is used and no hasant is required, as khanda ta is already a dead consonant. The rendering of khanda ta is illustrated in the third example in Figure 12-14.

Ya-phalaa. *Ya-phalaa* is a presentation form of U+09AF য় BENGALI LETTER YA. Represented by the sequence <U+09CD ্ BENGALI SIGN VIRAMA, U+09AF য় BENGALI LETTER YA>, *ya-phalaa* has a special form য়. When combined with U+09BE া BENGALI VOWEL SIGN AA, it is used for transcribing [æ] as in the “a” in the English word “bat.” The *ya-phalaa* appears in রাঁরা [ræʃ] “rash,” which provides a minimal pair with রাঁরা [raj] “a whole lot.”

Ya-phalaa can be applied to initial vowels as well:

অ্য = <0985, 09CD, 09AF, 09BE> (*a- hasant ya -aa*)

এ্য = <098F, 09CD, 09AF, 09BE> (*e- hasant ya -aa*)

If a candrabindu or other combining mark needs to be added in the sequence, it comes at the end of the sequence. For example:

অ্যঁ = <0985, 09CD, 09AF, 09BE, 0981> (*a- hasant ya -aa candrabindu*)

Further examples:

অ + ্ + য + া → অ্য

এ + ্ + য + া → এ্য

ত + ্ + য + া → ত্য

Interaction of Repha and Ya-phalaa. The formation of the *repha* form is defined in Section 12.1, *Devanagari*, “Rules for Rendering,” R2. Basically, the *repha* is formed when a ra that has the inherent vowel killed by the hasant begins a syllable. This scenario is shown in the following example:

র + ্ + ম → র্ম as in কর্ম (karma)

The *ya-phalaa* is a post-base form of *ya* and is formed when the *ya* is the final consonant of a syllable cluster. In this case, the previous consonant retains its base shape and the *hasant* is combined with the following *ya*. This scenario is shown in the following example:

ক + ্ + য → ক্য as in বাক্য (bakyô)

An ambiguous situation is encountered when the combination of *ra* + *hasant* + *ya* is encountered:

র + ্ + য → র্য or র্য

To resolve the ambiguity with this combination, the Unicode Standard adopts the convention of placing the character U+200D ZERO WIDTH JOINER immediately after the *ra* to obtain the *ya-phalaa*. The *repha* form is rendered when no ZWJ is present, as shown in the following example:

র + ্ + য → র্য

09B0 09CD 09AF

র + ZWJ + ্ + য → র্য

09B0 200D 09CD 09AF

When the first character of the cluster is not a *ra*, the *ya-phalaa* is the normal rendering of a *ya*, and a ZWJ is not necessary but can be present. Such a convention would make it possible, for example, for input methods to consistently associate *ya-phalaa* with the sequence <ZWJ, *hasant*, *ya*>.

Jihvamuliya and Upadhmaniya. In Bangla, the voiceless velar and bilabial fricatives are represented by U+1CF5 X VEDIC SIGN JIHVAMULIYA and U+1CF6 w VEDIC SIGN UPADHMANIYA, respectively. When the signs appear with a following homorganic voiceless stop consonant, they can be rendered in a font as a stacked ligature without a virama:

X + ক → X
ক

w + প → w
প

The sequences can also be represented linearly by inserting a U+200C ZERO WIDTH NON-JOINER after the *jihvamuliya* or *upadhmaniya*, but before the following consonant:

X + ZWJ + ক → Xক

w + ZWJ + প → wপ

Dependent vowel signs can also be added to the stack or linear sequence. Consonant clusters containing U+1CF5 VEDIC SIGN JIHVAMULIYA and U+1CF6 VEDIC SIGN UPADHMANIYA can occur with more than two consonants, such as *hkra* and *hpra*.

Punctuation. Bangla uses punctuation marks shared across many Indic scripts, including the *danda* and *double danda* marks. In Bangla these are called the *dahri* and *double dahri*. For a description of these common punctuation marks, see *Section 12.1, Devanagari*.

Truncation. The orthography of the Bangla language makes use of U+02BC “ ’ ” MODIFIER LETTER APOSTROPHE to indicate the truncation of words. This sign is called *urdha-comma*.

Examples illustrating the use of U+02BC “’” MODIFIER LETTER APOSTROPHE are shown in *Table 12-15*.

Table 12-15. Use of Apostrophe in Bangla

Example	Meaning
ক'রে	after, on doing (something)
'পরে ওপরে	} above

12.3 Gurmukhi

Gurmukhi: U+0A00–U+0A7F

The Gurmukhi script is a North Indian script used to write the Punjabi (or Panjabi) language of the Punjab state of India. Gurmukhi, which literally means “proceeding from the mouth of the Guru,” is attributed to Angad, the second Sikh Guru (1504–1552 CE). It is derived from an older script called Landa and is closely related to Devanagari structurally. The script is closely associated with Sikhs and Sikhism, but it is used on an everyday basis in East Punjab. (West Punjab, now in Pakistan, uses the Arabic script.)

Encoding Principles. The Gurmukhi block is based on ISCII-1988, which makes it parallel to Devanagari. Gurmukhi, however, has a number of peculiarities described here.

The additional consonants (called *pairin bindi*; literally, “with a dot in the foot,” in Punjabi) are primarily used to differentiate Urdu or Persian loan words. They include U+0A36 GURMUKHI LETTER SHA and U+0A33 GURMUKHI LETTER LLA, but do not include U+0A5C GURMUKHI LETTER RRA, which is genuinely Punjabi. For unification with the other scripts, ISCII-1991 considers *rra* to be equivalent to *dda+nukta*, but this decomposition is not considered in Unicode. At the same time, ISCII-1991 does not consider U+0A36 to be equivalent to <0A38, 0A3C>, or U+0A33 to be equivalent to <0A32, 0A3C>.

Two different marks can be associated with U+0902 DEVANAGARI SIGN ANUSVARA: U+0A02 GURMUKHI SIGN BINDI and U+0A70 GURMUKHI TIPPI. Present practice is to use *bindi* only with the dependent and independent forms of the vowels *aa*, *ii*, *ee*, *ai*, *oo*, and *au*, and with the independent vowels *u* and *uu*; *tippi* is used in the other contexts. Older texts may depart from this requirement. ISCII-1991 uses only one encoding point for both marks.

U+0A71 GURMUKHI ADDAK is a special sign to indicate that the following consonant is geminate. ISCII-1991 does not have a specific code point for addak and encodes it as a cluster. For example, the word ਪੱਗ *pagg*, “turban,” can be represented with the sequence <0A2A, 0A71, 0A17> (or <pa, addak, ga>) in Unicode, while in ISCII-1991 it would be <pa, ga, virama, ga>.

U+0A75 ੜ GURMUKHI SIGN YAKASH probably originated as a subjoined form of U+0A2F ਯ GURMUKHI LETTER YA. However, because its usage is relatively rare and not entirely predictable, it is encoded as a separate character. Some modern fonts render YAKASH with the glyph ੜ, which varies from the traditional shape found in the code charts. This character should occur after the consonant to which it attaches and before any vowel sign.

U+0A51 ੜ GURMUKHI SIGN UDAAT occurs in older texts and indicates a high tone. This character should occur after the consonant to which it attaches and before any vowel sign.

Unusual Usage of Vowel Signs. In older texts, such as the *Sri Guru Granth Sahib* (the Sikh holy book), one can find typographic clusters with a vowel sign attached to a vowel letter, or with two vowel signs attached to a consonant. The most common cases are ੜu attached to ੜ, as in ੜੁਆੜ and both the vowel signs ੜ and ੜ attached to a consonant, as in ੜੁਝਿੰਦ

goubinda; this is used to indicate the metrical shortening of /o/ or the lengthening of /u/ depending on the context. Other combinations are attested as well, such as ਗ੍ਰਿਾਨ *ghiana*, represented by the sequence <U+0A17, U+0A4D, U+0A39, U+0A3F, U+0A3E, U+0A28>.

Because of the combining classes of the characters U+0A4B GURMUKHI VOWEL SIGN OO and U+0A41 GURMUKHI VOWEL SIGN U, the sequences <consonant, U+0A4B, U+0A41> and <consonant, U+0A41, U+0A4B> are not canonically equivalent. To avoid ambiguity in representation, the first sequence, with U+0A4B before U+0A41, should be used in such cases. More generally, when a consonant or independent vowel is modified by multiple vowel signs, the sequence of the vowel signs in the underlying representation of the text should be: left, top, bottom, right.

Vowel Letters. Vowel letters are encoded atomically in Unicode, even if they can be analyzed visually as consisting of multiple parts. *Table 12-16* shows the letters that can be analyzed, the single code point that should be used to represent them in text, and the sequence of code points resulting from analysis that should not be used.

Table 12-16. Gurmukhi Vowel Letters

For	Use	Do Not Use
ਆ	0A06	<0A05, 0A3E>
ਇ	0A07	<0A72, 0A3F>
ਈ	0A08	<0A72, 0A40>
ਉ	0A09	<0A73, 0A41>
ਊ	0A0A	<0A73, 0A42>
ਏ	0A0F	<0A72, 0A47>
ਐ	0A10	<0A05, 0A48>
ਓ	0A13	<0A73, 0A4B>
ਔ	0A14	<0A05, 0A4C>

Tones. The Punjabi language is tonal, but the Gurmukhi script does not contain any specific signs to indicate tones. Instead, the voiced aspirates (*gha*, *jha*, *ddha*, *dha*) and the letter *ha* combine consonantal and tonal functions.

Ordering. U+0A73 GURMUKHI URA and U+0A72 GURMUKHI IRI are the first and third “letters” of the Gurmukhi syllabary, respectively. They are used as bases or bearers for some of the independent vowels, while U+0A05 GURMUKHI LETTER A is both the second “letter” and the base for the remaining independent vowels. As a result, the collation order for Gurmukhi is based on a seven-by-five grid:

- The first row is U+0A73 *ura*, U+0A05 *a*, U+0A72 *iri*, U+0A38 *sa*, U+0A39 *ha*.
- This row is followed by five main rows of consonants, grouped according to the point of articulation, as is traditional in all South and Southeast Asian scripts.
- The semiconsonants follow in the seventh row: U+0A2F *ya*, U+0A30 *ra*, U+0A32 *la*, U+0A35 *va*, U+0A5C *rra*.
- The letters with *nukta*, added later, are presented in a subsequent eighth row if needed.

Rendering Behavior. For general principles regarding the rendering of the Gurmukhi script, see the rules for rendering in *Section 12.1, Devanagari*. In many aspects, Gurmukhi is simpler than Devanagari. In modern Punjabi, there are no half-consonants, no half-forms, no *repha* (upper form of U+0930 DEVANAGARI LETTER RA), and no real ligatures. Rules R2–R5, R11, and R14 do not apply. Conversely, the behavior for subscript RA (rules R6–R8 and R13) applies to U+0A39 GURMUKHI LETTER HA and U+0A35 GURMUKHI LETTER VA, which also have subjoined forms, called *pairin* in Punjabi. The subjoined form for RA is like a knot, while the subjoined HA and VA are written the same as the base form, without the top bar, but are reduced in size. As described in rule R13, they attach at the bottom of the base consonant, and will “push” down any attached vowel sign for U or UU. When U+0A2F GURMUKHI LETTER YA follows a dead consonant, it assumes a different form called *addha* in Punjabi, without the leftmost part, and the dead consonant returns to the nominal form, as shown in *Table 12-17*.

Table 12-17. Gurmukhi Conjuncts

ਮ	+	੍	+	ਹ	→	ਮ੍ਹ	(<i>mha</i>)	pairin ha
ਪ	+	੍	+	ਰ	→	ਪ੍ਰ	(<i>pra</i>)	pairin ra
ਦ	+	੍	+	ਵ	→	ਦ੍ਵ	(<i>dva</i>)	pairin va
ਦ	+	੍	+	ਯ	→	ਦਯ	(<i>dya</i>)	addha ya

Other letters behaved similarly in old inscriptions, as shown in *Table 12-18*.

Table 12-18. Additional Pairin and Addha Forms in Gurmukhi

ਸ	+	◌੍ਰ	+	ਗ	→	ਸ੍ਰ	(<i>sga</i>)	pairin	ga
ਸ	+	◌੍ਰ	+	ਚ	→	ਸ੍ਚ	(<i>sca</i>)	pairin	ca
ਸ	+	◌੍ਰ	+	ਟ	→	ਸ੍ਟ	(<i>stta</i>)	pairin	tta
ਸ	+	◌੍ਰ	+	ਠ	→	ਸ੍ਠ	(<i>sttha</i>)	pairin	ttha
ਸ	+	◌੍ਰ	+	ਤ	→	ਸ੍ਤ	(<i>sta</i>)	pairin	ta
ਸ	+	◌੍ਰ	+	ਦ	→	ਸ੍ਦ	(<i>sda</i>)	pairin	da
ਸ	+	◌੍ਰ	+	ਨ	→	ਸ੍ਨ	(<i>sna</i>)	pairin	na
ਸ	+	◌੍ਰ	+	ਥ	→	ਸ੍ਥ	(<i>stha</i>)	pairin	tha
ਸ	+	◌੍ਰ	+	ਯ	→	ਸ੍ਯ	(<i>sya</i>)	pairin	ya
ਸ	+	◌੍ਰ	+	ਥ	→	ਸਥ	(<i>stha</i>)	addha	tha
ਸ	+	◌੍ਰ	+	ਮ	→	ਸਮ	(<i>sma</i>)	addha	ma

Older texts also exhibit another feature that is not found in modern Gurmukhi—namely, the use of a half- or reduced form for the first consonant of a cluster, whereas the modern practice is to represent the second consonant in a half- or reduced form. Joiners can be used to request this older rendering, as shown in *Table 12-19*. The reduced form of an initial U+0A30 GURMUKHI LETTER RA is similar to the Devanagari superscript RA (*repha*), but this usage is rare, even in older texts.

Table 12-19. Use of Joiners in Gurmukhi

ਸ	+	◌੍ਰ	+	ਵ	→	ਸ੍ਵ	(<i>sva</i>)		
ਰ	+	◌੍ਰ	+	ਵ	→	ਰ੍ਵ	(<i>rva</i>)		
ਸ	+	◌੍ਰ	+	ZW	+	ਵ	→	ਸ੍ਵ	(<i>sva</i>)
ਰ	+	◌੍ਰ	+	ZW	+	ਵ	→	ਰ੍ਵ	(<i>rva</i>)
ਸ	+	◌੍ਰ	+	ZW NJ	+	ਵ	→	ਸ੍ਵ	(<i>sva</i>)
ਰ	+	◌੍ਰ	+	ZW NJ	+	ਵ	→	ਰ੍ਵ	(<i>rva</i>)

A rendering engine for Gurmukhi should make accommodations for the correct positioning of the combining marks (see *Section 5.13, Rendering Nonspacing Marks*, and particularly *Figure 5-11*). This is important, for example, in the correct centering of the marks above and below U+0A28 GURMUKHI LETTER NA and U+0A20 GURMUKHI LETTER TTHA,

which are laterally symmetrical. It is also important to avoid collisions between the various upper marks, vowel signs, *bindi*, and/or *addak*.

Other Symbols. The religious symbol *khanda* sometimes used in Gurmukhi texts is encoded at U+262C ADI SHAKTI in the Miscellaneous Symbols block. U+0A74 GURMUKHI EK ONKAR, which is also a religious symbol, can have different presentation forms, which do not change its meaning. The font used in the code charts shows a highly stylized form; simpler forms look like the digit one, followed by a sign based on *ura*, along with a long upper tail.

Punctuation. Danda and double danda marks as well as some other unified punctuation used with Gurmukhi are found in the Devanagari block. See *Section 12.1, Devanagari*, for more information. Punjabi also uses Latin punctuation.

12.4 Gujarati

Gujarati: U+0A80–U+0AFF

The Gujarati script is a North Indian script closely related to Devanagari. It is most obviously distinguished from Devanagari by not having a horizontal bar for its letterforms, a characteristic of the older Kaithi script to which Gujarati is related. The Gujarati script is used to write the Gujarati language of the Gujarat state in India.

Vowel Letters. Vowel letters are encoded atomically in Unicode, even if they can be analyzed visually as consisting of multiple parts. *Table 12-20* shows the letters that can be analyzed, the single code point that should be used to represent them in text, and the sequence of code points resulting from analysis that should not be used.

Table 12-20. Gujarati Vowel Letters

For	Use	Do Not Use
અ	0A86	<0A85, 0ABE>
ઐ	0A8D	<0A85, 0AC5>
એ	0A8F	<0A85, 0AC7>
ઔ	0A90	<0A85, 0AC8>
ઑ	0A91	<0A85, 0AC9>
ઓ	0A93	<0A85, 0ACB> or <0A85, 0ABE, 0AC5>
઒	0A94	<0A85, 0ACC> or <0A85, 0ABE, 0AC8>
ૌ	0AC9	<0AC5, 0ABE>

Rendering Behavior. For rendering of the Gujarati script, see the rules for rendering in *Section 12.1, Devanagari*. Like other Brahmic scripts in the Unicode Standard, Gujarati uses the virama to form conjunct characters. The virama is informally called *khodo*, which means “lame” in Gujarati. Many conjunct characters, as in Devanagari, lose the vertical stroke; there are also vertical conjuncts. U+0AB0 GUJARATI LETTER RA takes special forms when it combines with other consonants, as shown in *Table 12-21*.

Marks for Transliteration of Arabic. The combining marks encoded in the range U+0AFA..U+0AFF are used for the transliteration of the Arabic script into Gujarati. This system of transliteration was devised in the late 19th century, and is used by Ismaili Khoja communities. These marks occur both in manuscripts and in printed materials.

The three forms of *nukta* encoded in the range U+0AFD..U+0AFF are diacritics, placed above regular Gujarati letters to create new letters corresponding to Arabic letters for non-Gujarati sounds. U+0AFF GUJARATI SIGN TWO-CIRCLE NUKTA ABOVE is used only with U+0A9D GUJARATI LETTER JHA, to transliterate the Arabic *zah*. U+0AFE GUJARATI SIGN

Table 12-21. Gujarati Conjuncts

ક	+	◌̣	+	ખ	→	કખ	(<i>kṣa</i>)
જ	+	◌̣	+	ઞ	→	જઞ	(<i>jña</i>)
ત	+	◌̣	+	ય	→	તય	(<i>tya</i>)
ટ	+	◌̣	+	ટ	→	ટટ	(<i>ṭṭa</i>)
ર	+	◌̣	+	ક	→	રક	(<i>rka</i>)
ક	+	◌̣	+	ર	→	કર	(<i>kra</i>)

CIRCLE NUKTA ABOVE is used with U+0A9D GUJARATI LETTER JHA to transliterate the Arabic *thal* and with U+0AB8 GUJARATI LETTER SA to transliterate the Arabic *theh*. U+0AFD GUJARATI SIGN THREE-DOT NUKTA ABOVE occurs with a number of different Gujarati letters, to transliterate a variety of Arabic letters.

U+0AFA GUJARATI SIGN SUKUN, U+0AFB GUJARATI SIGN SHADDA, and U+0AFC GUJARATI SIGN MADDAH are used to transliterate the Arabic *sukun*, *shadda*, and *maddah above*, respectively. These marks may be applied to a Gujarati letter which also uses one of the three above-base *nukta* diacritic marks. In such cases, the *nukta* occurs first in the combining sequence, followed by the *sukun*, *shadda*, or *maddah* mark. However, instead of being rendered above the *nukta* mark on the letter, the *sukun*, *shadda*, or *maddah* mark is rendered to the left of the *nukta* mark.

Punctuation. Words in Gujarati are separated by spaces. Danda and double danda marks as well as some other unified punctuation used with Gujarati are found in the Devanagari block; see *Section 12.1, Devanagari*.

12.5 Oriya (Odia)

Oriya: U+0B00–U+0B7F

The Oriya script is a North Indian script that is structurally similar to Devanagari, but with semicircular lines at the top of most letters instead of the straight horizontal bars of Devanagari. The shapes of the letters, particularly for vowel signs, show similarities to Tamil. The Oriya script is used to write the Odia language of the Odisha (Orissa) state in India, as well as minority languages such as Khondi and Santali.

Languages and scripts can be referred to in many different ways, and these terms may evolve over time. The Oriya script is an example of this: The preferred Latin transcription used in India for this script has shifted to the spelling *Odia* (as shown, for example, by changes to the Indian constitution). The Unicode Standard retains the traditional English spelling *Oriya* in discussion, to minimize the potential for confusion when referring to immutable, standardized character names in the standard, which were assigned long ago.

Special Characters. U+0B57 ORIYA AU LENGTH MARK is provided as an encoding for the right side of the surroundant vowel U+0B4C ORIYA VOWEL SIGN AU.

Vowel Letters. Vowel letters are encoded atomically in Unicode, even if they can be analyzed visually as consisting of multiple parts. *Table 12-22* shows the letters that can be analyzed, the single code point that should be used to represent them in text, and the sequence of code points resulting from analysis that should not be used.

Table 12-22. Oriya Vowel Letters

For	Use	Do Not Use
ୱ	0B06	<0B05, 0B3E>
ୱି	0B10	<0B0F, 0B57>
ୱି	0B14	<0B13, 0B57>

Rendering Behavior. For rendering of the Oriya script, see the rules for rendering in *Section 12.1, Devanagari*. Like other Brahmic scripts in the Unicode Standard, Oriya uses the virama to suppress the inherent vowel. Oriya has a visible virama, often being a lengthening of a part of the base consonant:

କ + ୍ → କ୍ (k)

The virama is also used to form conjunct consonants, as shown in *Table 12-23*.

Table 12-23. Oriya Conjuncts

କ	+	୍	+	ଷ	→	କ୍ଷ	(kṣa)
କ	+	୍	+	ତ	→	କ୍ତ	(kta)
ତ	+	୍	+	କ	→	ତ୍କ	(tka)
ତ	+	୍	+	ୟ	→	ତ୍ୟ	(tya)

Consonant Forms. In the initial position in a cluster, RA is reduced and placed above the following consonant, while it is also reduced in the second position:

ର + ୍ + ପ → ଫି (rpa)

ପ + ୍ + ର → ପ୍ର (pra)

Nasal and stop clusters may be written with conjuncts, or the anusvara may be used:

ଅ + ଡ + ୍ + କ → ଅକ୍ (aṅka)

ଅ + ୠ + କ → ଅକ୍ (aṅka)

Vowels. As with other scripts, some dependent vowels are rendered in front of their consonant, some appear after it, and some are placed above or below it. Some are rendered with parts both in front of and after their consonant. A few of the dependent vowels fuse with their consonants. U+0B01 ORIYA SIGN CANDRABINDU is used for nasal vowels. See Table 12-24.

Table 12-24. Oriya Vowel Placement

କ	+	ା	→	କା	(kā)
କ	+	ି	→	କି	(ki)
କ	+	ି	→	କି	(kī)
କ	+	ୁ	→	କୁ	(ku)
କ	+	ୁ	→	କୁ	(kū)
କ	+	ୃ	→	କୃ	(kr̥)
କ	+	େ	→	କେ	(ke)
କ	+	ୈ	→	କୈ	(kai)
କ	+	ୋ	→	କୋ	(ko)
କ	+	ୌ	→	କୌ	(kau)
କ	+	ଂ	→	କଂ	(kaṁ)

An orthography for the Kuvi language makes use of a macron-shaped length mark. It is displayed directly above written forms of the following three vowels to indicate their corresponding long vowels:

- [o] vowel letter *a*, or inherent vowel implied by consonant letters and conjuncts
- [a] vowel letter or sign *aa*
- [e] vowel letter or sign *e*

This length mark is represented in text by U+0B55 ORIYA SIGN OVERLINE. It occurs in the text representation directly after the letter or sign it modifies, and after any *nukta* which is present.

Oriya VA and WA. These two letters are extensions to the basic Oriya alphabet. Because Sanskrit वन *vana* becomes Oriya ବନ *bana* in orthography and pronunciation, an extended letter U+0B35 ORIYA LETTER VA was devised by dotting U+0B2C ORIYA LETTER BA for use in academic and technical text. For example, basic Oriya script cannot distinguish Sanskrit बव *bava* from बब *baba* or वव *vava*, but this distinction can be made with the modified version of *ba*. In some older sources, the glyph ବ is sometimes found for *va*; in others, ବ and ବ have been shown, which in a more modern type style would be ବ. The letter *va* is not in common use today.

In a consonant conjunct, subjoined U+0B2C ORIYA LETTER BA is usually—but not always—pronounced [wa]:

U+0B15 କ *ka* + U+0B4D ୠ *virama* + U+0B2C ବ *ba* → କ୍ୱ [kwa]

U+0B2E ମ *ma* + U+0B4D ୠ *virama* + U+0B2C ବ *ba* → ମ୍ବ [mba]

The extended Oriya letter U+0B71 ORIYA LETTER WA is sometimes used in Perso-Arabic or English loan words for [w]. It appears to have originally been devised as a ligature of ଓ *o* and ବ *ba*, but because ligatures of independent vowels and consonants are not normally used in Oriya, this letter has been encoded as a single character that does not have a decomposition. It is used initially in words or orthographic syllables to represent the foreign consonant; as a native semivowel, *virama* + *ba* is used because that is historically accurate. Glyph variants of *wa* are ୱ, ୱ, and ୱ.

Punctuation and Symbols. Danda and double danda marks as well as some other unified punctuation used with Oriya are found in the Devanagari block; see *Section 12.1, Devanagari*. The mark U+0B70 ORIYA ISSHAR is placed before names of persons who are deceased.

The sacred syllable *om* is formed by U+0B13 ORIYA LETTER O and U+0B01 ORIYA SIGN CANDRABINDU. Ligation of the two glyphs can be encouraged or discouraged by the use of U+200D ZERO WIDTH JOINER or U+200C ZERO WIDTH NON-JOINER between the two characters, as seen in *Table 12-25*. In the absence of a joiner, both the non-ligated and the ligated forms are acceptable renderings.

Fraction Characters. As for many other scripts of India, Oriya has characters used to denote fractional values. These were more commonly used before the advent of decimal

Table 12-25. Ligation for the Syllable *om*

ଓ	+	[ZW] J	+	ଠ	→	ଓ or ଓ
ଓ	+	[ZW] NJ	+	ଠ	→	ଓ

weights, measures, and currencies. Oriya uses six signs: three for quarter values (1/4, 1/2, 3/4) and three for sixteenth values (1/16, 1/8, and 3/16). These are used additively, with quarter values appearing before sixteenths. Thus U+0B73 ORIYA FRACTION ONE HALF followed by U+0B75 ORIYA FRACTION ONE SIXTEENTH represents the value 5/16.

12.6 Tamil

Tamil: U+0B80–U+0BFF

The Tamil script is descended from the South Indian branch of Brahmi. It is used to write the Tamil language of the Tamil Nadu state in India as well as minority languages such as Irula, the Dravidian language Badaga, and the Indo-European language Saurashtra. Tamil is also used in Sri Lanka, Singapore, and parts of Malaysia.

The Tamil script has fewer consonants than the other Indic scripts. When representing the “missing” consonants in transcriptions of languages such as Sanskrit or Saurashtra, superscript European digits are often used, so $\text{U}^2 = pha$, $\text{U}^3 = ba$, and $\text{U}^4 = bha$. The characters U+00B2, U+00B3, and U+2074 can be used to preserve this distinction in plain text. The Grantha script is often also used by Tamil speakers to write Sanskrit because Grantha contains these missing consonants.

The Tamil script also avoids the use of conjunct consonant forms, although a few conventional conjuncts are used.

Virama (Pulli). Because the Tamil encoding in the Unicode Standard is based on ISCII-1988 (Indian Script Code for Information Interchange), it makes use of the *abugida* model. An abugida treats the basic consonants as containing an inherent vowel, which can be canceled by the use of a visible mark, called a *virama* in Sanskrit. In most Brahmi-derived scripts, the placement of a virama between two consonants implies the deletion of the inherent vowel of the first consonant and causes a conjoined or subjoined consonant cluster. In those scripts, ZERO WIDTH NON-JOINER is used to display a visible virama, as shown previously in the Devanagari example in *Figure 12-4*.

The situation is quite different for Tamil because the script uses very few consonant conjuncts. An orthographic cluster consisting of multiple consonants (represented by <C1, U+0BCD TAMIL SIGN VIRAMA, C2, ...>) is normally displayed with explicit viramas, which are called *pulli* in Tamil. The *pulli* is typically rendered as a dot centered above the character. It occasionally appears as small circle instead of a dot, but this glyph variant should be handled by the font, and not be represented by the similar-appearing U+0B82 TAMIL SIGN ANUSVARA.

The conjuncts *kssa* and *shrii* are traditionally displayed by conjunct ligatures, as illustrated for *kssa* in *Figure 12-15*, but nowadays tend to be displayed using an explicit *pulli* as well.

Figure 12-15. Kssa Ligature in Tamil

க + ஃ + ள் → க்ஷ் *kṣa*

To explicitly display a *pulli* for such sequences, ZERO WIDTH NON-JOINER can be inserted after the *pulli* in the sequence of characters.

Rendering of the Tamil Script. The Tamil script is complex and requires special rules for rendering. The following discussion describes the most important features of Tamil rendering behavior. As with any script, a more complex procedure can add rendering characteristics, depending on the font and application.

In a font that is capable of rendering Tamil, the number of glyphs is greater than the number of Tamil characters.

Tamil Vowels

Vowel Letters. Vowel letters are encoded atomically in Unicode, even if they can be analyzed visually as consisting of multiple parts. *Table 12-26* shows the letters that can be analyzed, the single code point that should be used to represent them in text, and the sequence of code points resulting from analysis that should not be used.

Table 12-26. Tamil Vowel Letters

For	Use	Do Not Use
ஐ	0B86	<0B85, 0BC2>

Independent Versus Dependent Vowels. In the Tamil script, the dependent vowel signs are not equivalent to a sequence of *virama* + *independent vowel*. For example:

ன + ி ≠ ன + ஃ + இ

Left-Side Vowels. The Tamil vowels U+0BC6 ெ, U+0BC7 ே, and U+0BC8 ை are reordered in front of the consonant to which they are applied. When occurring in a syllable, these vowels are rendered to the left side of their consonant, as shown in *Figure 12-16*.

Figure 12-16. Tamil Vowel Reordering

க + ெ → கெ
 க + ே → கே
 க + ை → கை

Two-Part Vowels. Tamil also has several vowels that consist of elements which flank the consonant to which they are applied. A sequence of two Unicode code points can be used to express equivalent spellings for these vowels, as shown in *Figure 12-17*.

Figure 12-17. Tamil Two-Part Vowels

$$\begin{aligned} \text{ொ} \text{ } 0BCA &\equiv \text{ெ} + \text{ா} \text{ } 0BC6 + 0BBE \\ \text{ோ} \text{ } 0BCB &\equiv \text{ே} + \text{ா} \text{ } 0BC7 + 0BBE \\ \text{ௌ} \text{ } 0BCC &\equiv \text{ெ} + \text{ள} \text{ } 0BC6 + 0BD7 \end{aligned}$$

In these examples, the representation on the left, which is a single code point, is the preferred form and the form in common use for Tamil.

In the process of rendering, these two-part vowels are transformed into the two separate glyphs equivalent to those on the right, which are then subject to vowel reordering, as shown in *Figure 12-18*.

Figure 12-18. Tamil Vowel Splitting and Reordering

$$\begin{aligned} \text{க} + \text{ொ} &\rightarrow \text{கொ} \\ \text{க} + \text{ெ} + \text{ா} &\rightarrow \text{கொ} \\ \text{க} + \text{ோ} &\rightarrow \text{கோ} \\ \text{க} + \text{ே} + \text{ா} &\rightarrow \text{கோ} \\ \text{க} + \text{ௌ} &\rightarrow \text{கௌ} \\ \text{க} + \text{ெ} + \text{ள} &\rightarrow \text{கௌ} \end{aligned}$$

Even in the case where a two-part vowel occurs with a conjunct consonant or consonant cluster, the left part of the vowel is reordered around the conjunct or cluster, as shown in *Figure 12-19*.

Figure 12-19. Vowel Reordering Around a Tamil Conjunct

$$\text{க} + \text{்} + \text{ஷ} + \text{ெ} + \text{ா} \rightarrow \text{கெஷா} \text{ } k_{\text{šo}}$$

For either left-side vowels or two-part vowels, the ordering of the elements is unambiguous: the consonant or consonant cluster occurs first in the memory representation, followed by the vowel.

Confusable Vowels. U+0B94 TAMIL LETTER AU and U+0BCC TAMIL VOWEL SIGN AU are visually indistinguishable from two semantically unrelated sequences, as shown in *Figure 12-20*. In the decompositions of these two vowel characters, the rightmost part is represented as the character U+0BD7 TAMIL AU LENGTH MARK, which looks exactly like the separate character, U+0BB3 TAMIL LETTER LLA.

Figure 12-20. Confusable Vowels in Tamil

ஒள 0B94 ≡ ஒ + ாள 0B92 + 0BD7 ≠ ஒ + ளள 0B92 + 0BB3

ெள 0BCC ≡ ெ + ாள 0BC6 + 0BD7 ≠ ெ + ளள 0BC6 + 0BB3

Tamil Ligatures

A number of ligatures are conventionally used in Tamil. Most ligatures involve the shape taken by a consonant plus vowel sequence. A wide variety of modern Tamil words are written without a conjunct form, with a fully visible *pulli*.

Ligatures with Vowel i. The vowel signs *i* ி and *ii* ி form ligatures with the consonant *ta* ட as shown in examples 1 and 2 of *Figure 12-21*. These vowels often change shape or position slightly so as to join cursively with other consonants, as shown in examples 3 and 4 of *Figure 12-21*.

Figure 12-21. Tamil Ligatures with *i*

- ① ட + ி → டி *ti*
- ② ட + ி → டீ *tī*
- ③ ல + ி → லி *li*
- ④ ல + ி → லீ *lī*

Ligatures with Vowel u. The vowel signs *u* ஁ and *uu* ஁ normally ligate with their consonant, as shown in *Table 12-27*. In the first column, the basic consonant is shown; the second column illustrates the ligation of that consonant with the *u* vowel sign; and the third column illustrates the ligation with the *uu* vowel sign.

Table 12-27. Tamil Ligatures with *u*

<i>x</i>	<i>x</i> + ஁	<i>x</i> + ஁
க	கு	கூ
ங	ங்	ஙூ
ச	சு	சூ
ஞ	ஞ்	ஞூ
ட	டு	டூ

<i>x</i>	<i>x</i> + ஁	<i>x</i> + ஁
ப	பு	பூ
ம	மு	மூ
ய	யு	யூ
ர	ரு	ரூ
ற	று	றூ

Table 12-27. Tamil Ligatures with *u* (Continued)

<i>x</i>	<i>x</i> + ு	<i>x</i> + ூ
ண	ணு	ணுா
த	து	துா
ந	நு	நுா
ன	னு	னுா

<i>x</i>	<i>x</i> + ு	<i>x</i> + ூ
ல	லு	லுா
ள	ளு	ளுா
ழ	ழு	ழுா
வ	வு	வுா

With certain consonants, ஜ, வ், ஸ, ஹ, and the conjunct ச்ஷ, the vowel signs ு and ூ take a distinct spacing form, as shown in *Figure 12-22*.

Figure 12-22. Spacing Forms of Tamil *u*

ஜ + ு → ஜுா *ju*

ஜ + ூ → ஜுா *jū*

Ligatures with ra. Based on typographical preferences, the consonant *ra* ர may change shape to ர, when it ligates. Such change, if it occurs, will happen only when the ர form of U+0BB0 ர TAMIL LETTER RA would not be confused with the nominal form ர of U+0BBE TAMIL VOWEL SIGN AA (namely, when ர is combined with ு, ு, or ூ). This change in shape is illustrated in *Figure 12-23*.

Figure 12-23. Tamil Ligatures with *ra*

ர + ு → ரு *r*

ர + ு → ரு *ri*

ர + ூ → ரு *rī*

However, various governmental bodies mandate that the basic shape of the consonant *ra* ர should be used for these ligatures as well, especially in school textbooks. Media and literary publications in Malaysia and Singapore mostly use the unchanged form of *ra* ர. Sri Lanka, on the other hand, specifies the use of the changed forms shown in *Figure 12-23*.

Tamil Ligature shri. Prior to Unicode 4.1, the best mapping to represent the ligature *shri* was to the sequence <U+0BB8, U+0BCD, U+0BB0, U+0BC0>. Unicode 4.1 in 2005 added the character U+0BB6 TAMIL LETTER SHA and as a consequence, the best mapping became

<U+0BB6, U+0BCD, U+0BB0, U+0BC0>. Due to slow updates to implementations, both representations are widespread in existing text. Therefore, treating both representations as equivalent sequences is recommended. *Figure 12-24* shows the two sequences.

Figure 12-24. Tamil Ligatures for *shri*

ஸ + ◌̇ + ர + ீ → ஸ்ரீ
 ஸ + ◌̇ + ர + ீ → ஸ்ரீ

Ligatures with aa in Traditional Tamil Orthography. In traditional Tamil orthography, the vowel sign *aa* ◌̇ optionally ligates with ண, ண, or ற, as illustrated in *Figure 12-25*.

Figure 12-25. Traditional Tamil Ligatures with *aa*

ண + ◌̇ → (ண) ṅā
 ண + ◌̇ → (ண) ṅā
 ற + ◌̇ → (ற) rā

These ligations also affect the right-hand part of two-part vowels, as shown in *Figure 12-26*.

Figure 12-26. Traditional Tamil Ligatures with *o*

ண + ◌̇ொ → (ணொ) ṅo
 ண + ◌̇ோ → (ணோ) ṅō
 ண + ◌̇ொ → (ணொ) ṅo
 ண + ◌̇ோ → (ணோ) ṅō
 ற + ◌̇ொ → (றொ) ro
 ற + ◌̇ோ → (றோ) rō

Ligatures with ai in Traditional Tamil Orthography. In traditional Tamil orthography, the left-side vowel sign *ai* ◌̇ is also subject to a change in form. It is rendered as ீ̇ when it occurs on the left side of ண, ண, ஸ, or ஶ, as illustrated in *Figure 12-27*.

Figure 12-27. Traditional Tamil Ligatures with *ai*

ண + ை ◌ → ூண *ṅai*
 ன + ை ◌ → ூன *ṅai*
 ல + ை ◌ → ூல *lai*
 ள + ை ◌ → ூள *lai*

By contrast, in modern Tamil orthography, this vowel does not change its shape, as shown in *Figure 12-28*.

Figure 12-28. Vowel *ai* in Modern Tamil

ண + ை ◌ → ைண *ṅai*

Tamil aytham. The character U+0B83 TAMIL SIGN VISARGA is normally called *aytham* in Tamil. It is historically related to the *visarga* in other Indic scripts, but has become an ordinary spacing letter in Tamil. The *aytham* occurs in native Tamil words, but is frequently used as a modifying prefix before consonants used to represent foreign sounds. In particular, it is used in the spelling of words borrowed into Tamil from English or other languages.

Punctuation. Danda and double danda marks as well as some other unified punctuation used with Tamil are found in the Devanagari block; see *Section 12.1, Devanagari*.

Numbers. Modern Tamil decimal digits are encoded at U+0BE6..U+0BEF. Note that some digits are confusable with letters, as shown in *Table 12-28*. In some Tamil fonts, the digits for two and eight look exactly like the letters *u* and *a*, respectively. In other fonts, as shown here, the shapes for the digits two and eight are adjusted to minimize confusability.

Table 12-28. Confusable Tamil Digits

U+0BE7 ூ TAMIL DIGIT ONE	U+0B95 க TAMIL LETTER KA
U+0BE8 ு TAMIL DIGIT TWO	U+0B89 ூ TAMIL LETTER U
U+0BED ெ TAMIL DIGIT SEVEN	U+0B8E ெ TAMIL LETTER E
U+0BEE ை TAMIL DIGIT EIGHT	U+0B85 ை TAMIL LETTER A

Tamil also has distinct numerals for ten, one hundred, and one thousand at U+0BF0..U+0BF2 used for historical numbers.

Use of Nukta. In addition to Tamil, several other languages of southern India are written using the Tamil script. For example, Irula is written with the Tamil script. Some of these languages contain sounds distinct from those normally written for the Tamil language. In

such cases, the writing systems of these languages apply diacritic nukta marks to Tamil letters to represent their distinct sounds. For example, Irula uses a double dot nukta below represented with U+1133C GRANTHA SIGN NUKTA, and Badaga uses a single dot nukta represented by U+1133B COMBINING BINDU BELOW for some sounds.

Tamil Supplement: U+11FC0–U+11FFF

The Tamil Supplement block contains a set of fractions in the range U+11FC0..U+11FD4 used for generic measurement and calculations and for money. The block also includes symbols indicating various forms of measurement, old units of currency, agricultural and clerical signs, and other miscellaneous abbreviations. Most characters in this block are no longer in use, but a few appear in traditional contexts, such as on marriage invitations printed in a traditional format.

Tamil Named Character Sequences

Tamil is less complex than some of the other Indic scripts, and both conceptually and in processing can be treated as an atomic set of elements: consonants, stand-alone vowels, and syllables. *Table 12-29* shows these atomic elements, with the corresponding Unicode characters or sequences. In cases where the atomic elements for Tamil correspond to sequences of Unicode characters, those sequences have been added to the approved list of Unicode named character sequences. See `NamedSequences.txt` in the Unicode Character Database for details.

In implementations such as natural language processing, where it may be useful to treat such Tamil text elements as single code points for ease of processing, Tamil named character sequences could be mapped to code points in a contiguous segment of the Private Use Area.

In *Table 12-29*, the first row shows the transliterated representation of the Tamil vowels in abbreviated form, while the first column shows the transliterated representation of the Tamil consonants. Those row and column labels, together with identifying strings such as “TAMIL SYLLABLE” or “TAMIL CONSONANT” are concatenated to form formal names for these sequences. For example, the sequence shown in the table in the K row and the AA column, with the sequence `<0B95, 0BBE>`, gets the associated name `TAMIL SYLLABLE KAA`. The sequence shown in the table in the K row in the first column, with the sequence `<0B95, 0BCD>`, gets the associated name `TAMIL CONSONANT K`.

Details on the complete names for each element can be found in `NamedSequences.txt`.

Table 12-29. Tamil Vowels, Consonants, and Syllables

	A	AA	I	II	U	UU	E	EE	AI	O	OO	AU	
	அ 0B83	ஆ 0B85	இ 0B86	ஈ 0B87	உ 0B88	ஊ 0B89	எ 0B8A	ஏ 0B8E	ஐ 0B8F	ஓ 0B90	ஔ 0B92	ஔ 0B93	ஔ 0B94
K	க் 0B95 0BCD	க 0B95	கா 0B95 0BBE	கி 0B95 0BBF	கீ 0B95 0BC0	கு 0B95 0BC1	கூ 0B95 0BC2	கெ 0B95 0BC6	கே 0B95 0BC7	கை 0B95 0BC8	கொ 0B95 0BCA	கோ 0B95 0BCB	கௌ 0B95 0BCC
NG	ங் 0B99 0BCD	ங 0B99	ஙா 0B99 0BBE	ஙி 0B99 0BBF	ஙீ 0B99 0BC0	ஙு 0B99 0BC1	ஙூ 0B99 0BC2	ஙெ 0B99 0BC6	ஙே 0B99 0BC7	ஙை 0B99 0BC8	ஙொ 0B99 0BCA	ஙோ 0B99 0BCB	ஙௌ 0B99 0BCC
C	ச் 0B9A 0BCD	ச 0B9A	சா 0B9A 0BBE	சி 0B9A 0BBF	சீ 0B9A 0BC0	சு 0B9A 0BC1	சூ 0B9A 0BC2	செ 0B9A 0BC6	சே 0B9A 0BC7	சை 0B9A 0BC8	சொ 0B9A 0BCA	சோ 0B9A 0BCB	சௌ 0B9A 0BCC
NY	ஞ் 0B9E 0BCD	ஞ 0B9E	ஞா 0B9E 0BBE	ஞி 0B9E 0BBF	ஞீ 0B9E 0BC0	ஞு 0B9E 0BC1	ஞூ 0B9E 0BC2	ஞெ 0B9E 0BC6	ஞே 0B9E 0BC7	ஞை 0B9E 0BC8	ஞொ 0B9E 0BCA	ஞோ 0B9E 0BCB	ஞௌ 0B9E 0BCC
TT	ட் 0B9F 0BCD	ட 0B9F	டா 0B9F 0BBE	டி 0B9F 0BBF	டீ 0B9F 0BC0	டு 0B9F 0BC1	டூ 0B9F 0BC2	டெ 0B9F 0BC6	டே 0B9F 0BC7	டை 0B9F 0BC8	டொ 0B9F 0BCA	டோ 0B9F 0BCB	டௌ 0B9F 0BCC
NN	ண் 0BA3 0BCD	ண 0BA3	ணா 0BA3 0BBE	ணி 0BA3 0BBF	ணீ 0BA3 0BC0	ணு 0BA3 0BC1	ணூ 0BA3 0BC2	ணெ 0BA3 0BC6	ணே 0BA3 0BC7	ணை 0BA3 0BC8	ணொ 0BA3 0BCA	ணோ 0BA3 0BCB	ணௌ 0BA3 0BCC
T	த் 0BA4 0BCD	த 0BA4	தா 0BA4 0BBE	தி 0BA4 0BBF	தீ 0BA4 0BC0	து 0BA4 0BC1	தூ 0BA4 0BC2	தெ 0BA4 0BC6	தே 0BA4 0BC7	தை 0BA4 0BC8	தொ 0BA4 0BCA	தோ 0BA4 0BCB	தௌ 0BA4 0BCC
N	ந் 0BA8 0BCD	ந 0BA8	நா 0BA8 0BBE	நி 0BA8 0BBF	நீ 0BA8 0BC0	நு 0BA8 0BC1	நூ 0BA8 0BC2	நெ 0BA8 0BC6	நே 0BA8 0BC7	நை 0BA8 0BC8	நொ 0BA8 0BCA	நோ 0BA8 0BCB	நௌ 0BA8 0BCC
P	ப் 0BAA 0BCD	ப 0BAA	பா 0BAA 0BBE	பி 0BAA 0BBF	பீ 0BAA 0BC0	பு 0BAA 0BC1	பூ 0BAA 0BC2	பெ 0BAA 0BC6	பே 0BAA 0BC7	பை 0BAA 0BC8	பொ 0BAA 0BCA	போ 0BAA 0BCB	பௌ 0BAA 0BCC
M	ம் 0BAE 0BCD	ம 0BAE	மா 0BAE 0BBE	மி 0BAE 0BBF	மீ 0BAE 0BC0	மு 0BAE 0BC1	மூ 0BAE 0BC2	மெ 0BAE 0BC6	மே 0BAE 0BC7	மை 0BAE 0BC8	மொ 0BAE 0BCA	மோ 0BAE 0BCB	மௌ 0BAE 0BCC
Y	ய் 0BAF 0BCD	ய 0BAF	யா 0BAF 0BBE	யி 0BAF 0BBF	யீ 0BAF 0BC0	யு 0BAF 0BC1	யூ 0BAF 0BC2	யெ 0BAF 0BC6	யே 0BAF 0BC7	யை 0BAF 0BC8	யொ 0BAF 0BCA	யோ 0BAF 0BCB	யௌ 0BAF 0BCC
R	ர் 0BB0 0BCD	ர 0BB0	ரா 0BB0 0BBE	ரி 0BB0 0BBF	ரீ 0BB0 0BC0	ரு 0BB0 0BC1	ரூ 0BB0 0BC2	ரெ 0BB0 0BC6	ரே 0BB0 0BC7	ரை 0BB0 0BC8	ரொ 0BB0 0BCA	ரோ 0BB0 0BCB	ரௌ 0BB0 0BCC
L	ல் 0BB2 0BCD	ல 0BB2	லா 0BB2 0BBE	லி 0BB2 0BBF	லீ 0BB2 0BC0	லு 0BB2 0BC1	லூ 0BB2 0BC2	லெ 0BB2 0BC6	லே 0BB2 0BC7	லை 0BB2 0BC8	லொ 0BB2 0BCA	லோ 0BB2 0BCB	லௌ 0BB2 0BCC

Table 12-29. Tamil Vowels, Consonants, and Syllables (Continued)

	A	AA	I	II	U	UU	E	EE	AI	O	OO	AU	
V	வ் 0BB5 0BCD	வ 0BB5	வா 0BB5 0BBE	வி 0BB5 0BBF	வீ 0BB5 0BC0	வு 0BB5 0BC1	வூ 0BB5 0BC2	வெ 0BB5 0BC6	வே 0BB5 0BC7	வை 0BB5 0BC8	வொ 0BB5 0BCA	வோ 0BB5 0BCB	வௌ 0BB5 0BCC
LLL	ழ் 0BB4 0BCD	ழ 0BB4	ழா 0BB4 0BBE	ழி 0BB4 0BBF	ழீ 0BB4 0BC0	ழு 0BB4 0BC1	ழூ 0BB4 0BC2	ழெ 0BB4 0BC6	ழே 0BB4 0BC7	ழை 0BB4 0BC8	ழொ 0BB4 0BCA	ழோ 0BB4 0BCB	ழௌ 0BB4 0BCC
LL	ள் 0BB3 0BCD	ள 0BB3	ளா 0BB3 0BBE	ளி 0BB3 0BBF	ளீ 0BB3 0BC0	ளு 0BB3 0BC1	ளூ 0BB3 0BC2	ளெ 0BB3 0BC6	ளே 0BB3 0BC7	ளை 0BB3 0BC8	ளொ 0BB3 0BCA	ளோ 0BB3 0BCB	ளௌ 0BB3 0BCC
RR	ற் 0BB1 0BCD	ற 0BB1	றா 0BB1 0BBE	றி 0BB1 0BBF	றீ 0BB1 0BC0	று 0BB1 0BC1	றூ 0BB1 0BC2	றெ 0BB1 0BC6	றே 0BB1 0BC7	றை 0BB1 0BC8	றொ 0BB1 0BCA	றோ 0BB1 0BCB	றௌ 0BB1 0BCC
NNN	ன் 0BA9 0BCD	ன 0BA9	னா 0BA9 0BBE	னி 0BA9 0BBF	னீ 0BA9 0BC0	னு 0BA9 0BC1	னூ 0BA9 0BC2	னெ 0BA9 0BC6	னே 0BA9 0BC7	னை 0BA9 0BC8	னொ 0BA9 0BCA	னோ 0BA9 0BCB	னௌ 0BA9 0BCC
J	ஜ் 0B9C 0BCD	ஜ 0B9C	ஜா 0B9C 0BBE	ஜி 0B9C 0BBF	ஜீ 0B9C 0BC0	ஜு 0B9C 0BC1	ஜூ 0B9C 0BC2	ஜெ 0B9C 0BC6	ஜே 0B9C 0BC7	ஜை 0B9C 0BC8	ஜொ 0B9C 0BCA	ஜோ 0B9C 0BCB	ஜௌ 0B9C 0BCC
SH	ஸ் 0BB6 0BCD	ஸ 0BB6	ஸா 0BB6 0BBE	ஸி 0BB6 0BBF	ஸீ 0BB6 0BC0	ஸு 0BB6 0BC1	ஸூ 0BB6 0BC2	ஸெ 0BB6 0BC6	ஸே 0BB6 0BC7	ஸை 0BB6 0BC8	ஸொ 0BB6 0BCA	ஸோ 0BB6 0BCB	ஸௌ 0BB6 0BCC
SS	ஷ் 0BB7 0BCD	ஷ 0BB7	ஷா 0BB7 0BBE	ஷி 0BB7 0BBF	ஷீ 0BB7 0BC0	ஷு 0BB7 0BC1	ஷூ 0BB7 0BC2	ஷெ 0BB7 0BC6	ஷே 0BB7 0BC7	ஷை 0BB7 0BC8	ஷொ 0BB7 0BCA	ஷோ 0BB7 0BCB	ஷௌ 0BB7 0BCC
S	ஸ் 0BB8 0BCD	ஸ 0BB8	ஸா 0BB8 0BBE	ஸி 0BB8 0BBF	ஸீ 0BB8 0BC0	ஸு 0BB8 0BC1	ஸூ 0BB8 0BC2	ஸெ 0BB8 0BC6	ஸே 0BB8 0BC7	ஸை 0BB8 0BC8	ஸொ 0BB8 0BCA	ஸோ 0BB8 0BCB	ஸௌ 0BB8 0BCC
H	ஹ் 0BB9 0BCD	ஹ 0BB9	ஹா 0BB9 0BBE	ஹி 0BB9 0BBF	ஹீ 0BB9 0BC0	ஹு 0BB9 0BC1	ஹூ 0BB9 0BC2	ஹெ 0BB9 0BC6	ஹே 0BB9 0BC7	ஹை 0BB9 0BC8	ஹொ 0BB9 0BCA	ஹோ 0BB9 0BCB	ஹௌ 0BB9 0BCC
KSS	க்ஷ் 0B95 0BCD 0BB7 0BCD	க்ஷ 0B95 0BCD 0BB7	க்ஷா 0B95 0BCD 0BB7 0BBE	க்ஷி 0B95 0BCD 0BB7 0BBF	க்ஷீ 0B95 0BCD 0BB7 0BC0	க்ஷு 0B95 0BCD 0BB7 0BC1	க்ஷூ 0B95 0BCD 0BB7 0BC2	க்ஷெ 0B95 0BCD 0BB7 0BC6	க்ஷே 0B95 0BCD 0BB7 0BC7	க்ஷை 0B95 0BCD 0BB7 0BC8	க்ஷொ 0B95 0BCD 0BB7 0BCA	க்ஷோ 0B95 0BCD 0BB7 0BCB	க்ஷௌ 0B95 0BCD 0BB7 0BCC

SHRII	ஸ்ரீ 0BB6 0BCD 0BB0 0BC0
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12.7 Telugu

Telugu: U+0C00–U+0C7F

The Telugu script is a South Indian script used to write the Telugu language of the Andhra Pradesh state in India as well as minority languages such as Gondi (Adilabad and Koi dialects) and Lambadi. The script is also used in Maharashtra, Odisha (Orissa), Madhya Pradesh, and West Bengal. The Telugu script became distinct by the thirteenth century CE and shares ancestors with the Kannada script.

Vowel Letters. Vowel letters are encoded atomically in Unicode, even if they can be analyzed visually as consisting of multiple parts. *Table 12-30* shows the letters that can be analyzed, the single code point that should be used to represent them in text, and the sequence of code points resulting from analysis that should not be used.

Table 12-30. Telugu Vowel Letters

For	Use	Do Not Use
ఁ	0C13	<0C12, 0C55>
ఌ	0C14	<0C12, 0C4C>
఍	0C40	<0C3F, 0C55>
ఐ	0C47	<0C46, 0C55>
ఊ	0C4B	<0C4A, 0C55>

Rendering Behavior. Telugu script rendering is similar to that of some other Brahmic scripts in the Unicode Standard—in particular, the Kannada script. (See *Section 12.8, Kannada*.) Many Telugu letters have a v-shaped headstroke, which is a structural mark corresponding to the horizontal bar in Devanagari and the arch in Oriya. When a virama (called *virāmanu* in Telugu) or certain vowel signs are added to a letter with this headstroke, it is replaced:

U+0C15 క *ka* + U+0C4D ఱ virama → క̣ (*k*)

U+0C15 క *ka* + U+0C3F ఱ vowel sign *i* → కి (*ki*)

Telugu consonant clusters are most commonly represented by a subscripted, and often transformed, consonant glyph for the second element of the cluster:

U+0C17 గ *ga* + U+0C4D ఱ virama + U+0C17 గ *ga* → గ్గ (*gga*)

U+0C15 క *ka* + U+0C4D ఱ virama + U+0C15 క *ka* → క్క (*kka*)

U+0C15 క *ka* + U+0C4D ఱ virama + U+0C2F య *ya* → క్య (*kya*)

U+0C15 క *ka* + U+0C4D ఱ virama + U+0C37 ష *ssa* → క్ష (*kṣa*)

U+200C ZERO WIDTH NON-JOINER is used to prevent U+0C4D TELUGU SIGN VIRAMA from subscripting a following letter:

U+0C15 క *ka* + U+0C4D ీ *virama* + U+200C ZW ZWNJ + U+0C15 క
ka → క̣క (*k.ka*)

Nakāra-Pollu. A distinct form ీ of a vowelless U+0C28 న TELUGU LETTER NA appears in older Telugu texts, and is known as *nakāra-pollu*. This form is represented by a separate character, U+0C5D ీ TELUGU LETTER NAKAARA POLLU. The related form regularly used in modern texts takes an ordinary virama-joined shape ీ, as other consonants do, and thus is represented by the sequence <U+0C28 న, U+0C4D ీ *virama*>.

Prior to Unicode 14.0, these two distinct forms were treated as glyphic variants of that regular sequence <U+0C28 న, U+0C4D ీ *virama*>, handled at the font level.

Reph. In modern Telugu, U+0C30 TELUGU LETTER RA behaves in the same manner as most other initial consonants in a consonant cluster. That is, the *ra* appears in its nominal form, and the second consonant takes the C2-conjoining or subscripted form:

U+0C30 ర *ra* + U+0C4D ీ *virama* + U+0C2E మ *ma* → ర్మ (rma)

However, in older texts, U+0C30 TELUGU LETTER RA takes the reduced (or *reph*) form ీ when it appears first in a consonant cluster, and the following consonant maintains its nominal form:

U+0C30 ర *ra* + U+0C4D ీ *virama* + U+0C2E మ *ma* → మ్మ (rma)

U+200D ZERO WIDTH JOINER is placed immediately after the *virama* to render the *reph* explicitly in modern texts:

U+0C30 ర *ra* + U+0C4D ీ *virama* + U+200D ZW ZWJ + U+0C2E మ *ma*
 → మ్మ

To prevent display of a *reph*, U+200D ZERO WIDTH JOINER is placed after the *ra*, but preceding the *virama*:

U+0C30 ర *ra* + U+200D ZW ZWJ + U+0C4D ీ *virama* + U+0C2E మ *ma*
 → ర్మ

Special Characters. U+0C55 TELUGU LENGTH MARK is provided as an encoding for the distinguishing element appearing in certain letters and signs, however, this character is not used in ordinary representation of Telugu texts. See “Vowel Letters” earlier in this section for more information. U+0C56 TELUGU AI LENGTH MARK is provided as an encoding for the second element of the surroundrant vowel U+0C48 TELUGU VOWEL SIGN AI. The length marks are both nonspacing characters. For a detailed discussion of the use of two-part vowels, see “Two-Part Vowels” in *Section 12.6, Tamil*.

For scholarly orthographies in which a horizontal line below is used to denote an alternative vowel or consonant for a syllable, U+0952 DEVANAGARI STRESS SIGN ANUDATTA is recommended to represent the line analogously to a *svara* in an orthographic syllable. For the encoding order of *svaras*, see R10 of “Rendering Devanagari” in *Section 12.1, Devanagari*.

Nukta. U+0C3C TELUGU SIGN NUKTA is a mark placed under letters to indicate additional sounds from Tamil and Perso-Arabic languages. It may display as a large dot or as a ring, and is typically placed low enough to avoid confusion and collision with the differentiating “teardrop” that occurs under many Telugu letters. The representative glyph in the code chart is shown with the ring form to minimize accidental confusability in implementations.

Fractions. Prior to the adoption of the metric system, Telugu fractions were used as part of the system of measurement. Telugu fractions are quaternary (base-4), and use eight marks, which are conceptually divided into two sets. The first set represents odd-numbered negative powers of four in fractions. The second set represents even-numbered negative powers of four in fractions. Different zeros are used with each set. The zero from the first set is known as *halli*, U+0C78 TELUGU FRACTION DIGIT ZERO FOR ODD POWERS OF FOUR. The zero for the second set is U+0C66 TELUGU DIGIT ZERO.

Punctuation. Danda and double danda are used primarily in the domain of religious texts to indicate the equivalent of a comma and full stop, respectively. The danda and double danda marks as well as some other unified punctuation used with Telugu are found in the Devanagari block; see *Section 12.1, Devanagari*.

12.8 Kannada

Kannada: U+0C80–U+0CFF

The Kannada script is a South Indian script. It is used to write the Kannada (or Kanarese) language of the Karnataka state in India and to write minority languages such as Tulu. The Kannada language is also used in many parts of Tamil Nadu, Kerala, Andhra Pradesh, and Maharashtra. This script is very closely related to the Telugu script both in the shapes of the letters and in the behavior of conjunct consonants. The Kannada script also shares many features common to other Indic scripts. See *Section 12.1, Devanagari*, for further information.

The Unicode Standard follows the ISCII layout for encoding, which also reflects the traditional Kannada alphabetic order.

Principles of the Kannada Script

Like Devanagari and related scripts, the Kannada script employs a halant, which is also known as a virama or vowel omission sign, U+0CCD ೀ KANNADA SIGN VIRAMA. The halant nominally serves to suppress the inherent vowel of the consonant to which it is applied. The halant functions as a combining character. When a consonant loses its inherent vowel by the application of halant, it is known as a dead consonant. The dead consonants are the presentation forms used to depict the consonants without an inherent vowel. Their rendered forms in Kannada resemble the full consonant with the horn replaced by the halant sign. In contrast, a live consonant is a consonant that retains its inherent vowel or is written with an explicit dependent vowel sign. The dead consonant is defined as a sequence consisting of a consonant letter followed by a halant. The default rendering for a dead consonant is to position the halant as a combining mark bound to the consonant letterform.

Vowel Letters. Vowel letters are encoded atomically in Unicode, even if they can be analyzed visually as consisting of multiple parts. *Table 12-31* shows the letters that can be analyzed, the single code point that should be used to represent them in text, and the sequence of code points resulting from analysis that should not be used.

Table 12-31. Kannada Vowel Letters

For	Use	Do Not Use
ಉ	0C8A	<0C89, 0CBE>
ಊ	0C94	<0C92, 0CCC>
ಋ	0CE0	<0C8B, 0CBE>

Consonant Conjuncts. Kannada is also noted for a large number of consonant conjunct forms that serve as ligatures of two or more adjacent forms. This use of ligatures takes place in the context of a consonant cluster. A written consonant cluster is defined as a sequence

of characters that represent one or more dead consonants followed by a normal live consonant. A separate and unique glyph corresponds to each part of a Kannada consonant conjunct. Most of these glyphs resemble their original consonant forms—many without the implicit vowel sign, wherever applicable.

In Kannada, conjunct formation tends to be graphically regular, using the following pattern:

- The first consonant of the cluster is rendered with the implicit vowel or a different dependent vowel appearing as the terminal element of the cluster.
- The remaining consonants (consonants between the first consonant and the terminal vowel element) appear in conjunct consonant glyph forms in phonetic order. They are generally depicted directly below or to the lower right of the first consonant.

A Kannada script font contains the conjunct glyph components, but they are not encoded as separate Unicode characters because they are simply ligatures. Kannada script rendering software must be able to map appropriate combinations of characters in context to the appropriate conjunct glyphs in fonts.

In a font that is capable of rendering Kannada, the number of glyphs is greater than the number of encoded Kannada characters.

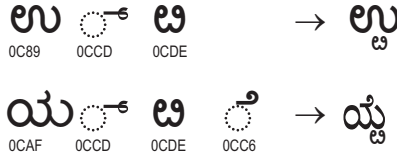
Special Characters. U+0CD5 ೀ KANNADA LENGTH MARK is provided as an encoding for the right side of the two-part vowel U+0CC7 ು KANNADA VOWEL SIGN EE should it be necessary for processing. Likewise, U+0CD6 ು KANNADA AI LENGTH MARK is provided as an encoding for the right side of the two-part vowel U+0CC8 ೂ KANNADA VOWEL SIGN AI. The Kannada two-part vowels actually consist of a nonspacing element above the consonant letter and one or more spacing elements to the right of the consonant letter. These two length marks have no independent existence in the Kannada writing system and do not play any part as independent codes in the traditional collation order.

Kannada Letter LLLA. U+0CDE ಁ KANNADA LETTER FA is actually an archaic Kannada letter that is transliterated in Dravidian scholarship as *z*, *l*, or *r*. This form should have been named “LLLA”, rather than “FA”, so the name in this standard is simply a mistake. A formal name alias KANNADA LETTER LLLA has been added to the Unicode Character Database for this character, to clarify its identity. Collations should treat U+0CDE as following U+0CB3 KANNADA LETTER LLA.

The *letter llla* has not been actively used in writing the Kannada language since the end of the tenth century. However, the letter does have modern use in writing the closely related Badaga language. Badaga is noteworthy for having distinct retroflexion in its vowel system, and a subjoined form of U+0CDE is often seen in Badaga written documents, to indicate retroflexed pronunciation of the vowel in a syllable. This subjoined form of U+0CDE may occur below consonants, but it also may be subjoined to an independent vowel, to indicate retroflexion of that vowel. In either case, the subjoined form of U+0CDE should be represented by a sequence including U+0CCD KANNADA SIGN VIRAMA. Implementations of the Kannada script need to be aware that these sequences involving independent vowels fol-

lowed by virama and U+0CDE are valid and required in orthographies for Badaga. Examples of the use of subjoined U+0CDE to indicate retroflexion, both for independent vowel letters and for dependent vowels, are shown in *Figure 12-29*.

Figure 12-29. Indicating Retroflexion in Badaga Vowels



Rendering Kannada

Plain text in Kannada is generally stored in phonetic order; that is, a CV syllable with a dependent vowel is always encoded as a consonant letter C followed by a vowel sign V in the memory representation. This order is employed by the ISCII standard and corresponds to the phonetic and keying order of textual data.

Explicit Virama (Halant). Normally, a halant character creates dead consonants, which in turn combine with subsequent consonants to form conjuncts. This behavior usually results in a halant sign not being depicted visually. Occasionally, this default behavior is not desired when a dead consonant should be excluded from conjunct formation, in which case the halant sign is visibly rendered. To accomplish this, U+200C ZERO WIDTH NON-JOINER is introduced immediately after the encoded dead consonant that is to be excluded from conjunct formation. See *Section 12.1, Devanagari*, for examples.

Vowelless NA. A special form, ಳ, of a vowelless *na* appears in older Kannada texts, distinct from the usual form of the vowelless *na* in modern texts: ನ್. The historic form is represented by a separate character, U+0CDD KANNADA LETTER NAKAARA POLLU. This character is named after the analogous Telugu form, *nakāra-pollu*, because there is no conventional term for this form in Kannada. Prior to Unicode 14.0, these two forms were treated as glyphic variants of <U+0CA8 KANNADA LETTER NA, U+0CCD KANNADA SIGN VIRAMA>, handled at the font level.

Consonant Clusters Involving RA. Whenever a consonant cluster is formed with the U+0CB0 ರ KANNADA LETTER RA as the first component of the consonant cluster, the letter *ra* is depicted with two different presentation forms: one as the initial element and the other as the final display element of the consonant cluster.

U+0CB0 ರ *ra* + U+0CCD ಃ *halant* + U+0C95 ಕ *ka* → ರ್ಕ *rka*

U+0CB0 ರ *ra* + zw + U+0CCD ಃ *halant* + U+0C95 ಕ *ka* → ರ್ಕ *rka*

U+0C95 ಕ *ka* + U+0CCD ಃ *halant* + U+0CB0 ರ *ra* → ಕ್ರ *kra*

Jihvamuliya and Upadhmaniya. Voiceless velar and bilabial fricatives in Kannada are represented by U+0CF1 KANNADA SIGN JIHVAMULIYA and U+0CF2 KANNADA SIGN UPADH-

MANIYA, respectively. When the signs appear with a following homorganic voiceless stop consonant, the combination should be rendered in the font as a stacked ligature, without a virama:

U+0CF1 ᳵ *jihvamuliya* + U+0C95 ಕ *ka* → $\text{ᳵ}_\text{ಕ}$

U+0CF2 ಃಃ *upadhmaniya* + U+0CAB ಫ *pha* → ಃಃಫ

Dependent vowel signs can also be added to the stack:

U+0CF1 ᳵ *jihvamuliya* + U+0C95 ಕ *ka* + U+0CBF ◌ಿ *vowel sign i* → $\text{ᳵ}_\text{ಕಿ}$

Modifier Mark Rules. In addition to the vowel signs, one or more types of combining marks may be applied to a component of a written syllable or the syllable as a whole. If the consonant represents a dead consonant, then the nukta should precede the halant in the memory representation. The nukta is represented by a double-dot mark, U+0CBC ᳚ KANNADA SIGN NUKTA. Two such modified consonants are used in the Kannada language: one representing the syllable *za* and one representing the syllable *fa*.

Avagraha Sign. A spacing mark, U+0CBD ᳛ KANNADA SIGN AVAGRAHA, is used when rendering Sanskrit texts.

Punctuation. Danda and double danda marks as well as some other unified punctuation used with this script are found in the Devanagari block; see *Section 12.1, Devanagari*.

12.9 Malayalam

Malayalam: U+0D00–U+0D7F

The Malayalam script is a South Indian script used to write the Malayalam language of the Kerala state. Malayalam is a Dravidian language like Kannada, Tamil, and Telugu. Throughout its history, it has absorbed words from Tamil, Sanskrit, Arabic, and English.

The shapes of Malayalam letters closely resemble those of Tamil. Malayalam, however, has a very full and complex set of conjunct consonant forms.

Vowel Letters. Vowel letters are encoded atomically in Unicode, even if they can be analyzed visually as consisting of multiple parts. *Table 12-32* shows the letters that can be analyzed, the single code point that should be used to represent them in text, and the sequence of code points resulting from analysis that should not be used.

Table 12-32. Malayalam Vowel Letters

For	Use	Do Not Use
ഇഊ	0D08	<0D07, 0D57>
ഉഊ	0D0A	<0D09, 0D57>
ഈഎ	0D10	<0D0E, 0D46>
ഈ	0D13	<0D12, 0D3E>
ഈ	0D14	<0D12, 0D57>

Two-Part Vowels. The Malayalam script uses several two-part vowel characters. In modern times, the dominant practice is to write the dependent form of the *au* vowel using only “ഊ”, which is placed on the right side of the consonant it modifies; such texts are represented in Unicode using U+0D57 MALAYALAM AU LENGTH MARK. In the past, this dependent form was written using both “ഈ” on the left side and “ഊ” on the right side; U+0D4C MALAYALAM VOWEL SIGN AU can be used for documents following this earlier tradition. This historical simplification started much earlier than the orthographic reforms mentioned in the text that follows.

For a detailed discussion of the use of two-part vowels, see “Two-Part Vowels” in *Section 12.6, Tamil*.

Historic and Scholarly Characters. U+0D5F MALAYALAM LETTER ARCHAIC II represents an earlier form for the vowel letter *ii*. Characters for the letters and signs of *vocalic rr*, *vocalic l*, and *vocalic ll*, as well as *candrabindu* and *avagraha*, are only used in Sanskrit texts. U+0D54..U+0D56 are rarely used *chillu* forms, found only in historical materials.

U+0D3B MALAYALAM SIGN VERTICAL BAR VIRAMA and U+0D3C MALAYALAM SIGN CIRCULAR VIRAMA are two specific forms of viramas found in historical materials. They were used to indicate a pure consonant in different orthographies. U+0D00 MALAYALAM SIGN COM-

BINING ANUSVARA ABOVE is used in certain Prakrit texts, where the ordinary *anusvara* indicates gemination of the following consonant.

U+0D3A MALAYALAM LETTER TTTA and U+0D29 MALAYALAM LETTER NNNA are used in scholarly orthographies for transcribing the Malayalam language in a phonetically accurate way. They represent the alveolar plosive and nasal, respectively. The letter *nnna* is parallel to U+0BA9 TAMIL LETTER NNNA.

Suriyani Malayalam. The Suriyani dialect of Malayalam is written using the Syriac script. It is also called Garshuni (Karshoni) or Syriac Malayalam. This usage requires eleven additional letters encoded in the Syriac Supplement block (U+0860..U+086F) to represent the sounds of Malayalam. The dialect was widely used by the St. Thomas Christians living in Kerala, India, in the 19th century.

Malayalam Orthographic Reform

In the 1970s and 1980s, Malayalam underwent orthographic reform due to printing difficulties. The treatment of the combining vowel signs *u* and *uu* was simplified at this time. These vowel signs had previously been represented using special cluster graphemes where the vowel signs were fused beneath their consonants, but in the reformed orthography they are represented by spacing characters following their consonants. *Table 12-33* lists a variety of consonants plus the *u* or *uu* vowel sign, yielding a syllable. Each syllable is shown as it would be displayed in the older orthography, contrasted with its display in the reformed orthography.

Table 12-33. Malayalam Orthographic Reform

Syllable		Older Orthography	Reformed Orthography
<i>ku</i>	ക + ു	ക	കു
<i>gu</i>	ഗ + ു	ഗ	ഗു
<i>chu</i>	ച + ു	ച	ചു
<i>ju</i>	ജ + ു	ജ	ജു
<i>nu</i>	ണ + ു	ണ	ണു
<i>tu</i>	ത + ു	ത	തു
<i>nu</i>	ന + ു	ന	നു
<i>bhu</i>	ഭ + ു	ഭ	ഭു
<i>ru</i>	ര + ു	ര	രു
<i>śu</i>	ശ + ു	ശ	ശു
<i>hu</i>	ഹ + ു	ഹ	ഹു
<i>kū</i>	ക + ൂ	ക	കൂ
<i>gū</i>	ഗ + ൂ	ഗ	ഗൂ

Table 12-33. Malayalam Orthographic Reform (Continued)

<i>chū</i>	ച + ൃ	ചൂ	ചു
<i>jū</i>	ജ + ൃ	ജൂ	ജു
<i>ñū</i>	ണ + ൃ	ണൂ	ണു
<i>tū</i>	ത + ൃ	തൂ	തു
<i>nū</i>	ന + ൃ	നൂ	നു
<i>bhū</i>	ഭ + ൃ	ഭൂ	ഭു
<i>rū</i>	ര + ൃ	രൂ	രു
<i>śū</i>	ശ + ൃ	ശൂ	ശു
<i>hū</i>	ഹ + ൃ	ഹൂ	ഹു

Rendering Malayalam

Candrakkala. As is the case for many other Brahmi-derived scripts in the Unicode Standard, Malayalam uses a virama character to form consonant conjuncts. The virama sign itself is known as *candrakkala* in Malayalam. *Table 12-34* provides a variety of examples of consonant conjuncts. There are both horizontal and vertical conjuncts, some of which ligate, and some of which are merely juxtaposed.

Table 12-34. Malayalam Conjuncts

ക	+	ഃ	+	ഷ	→	കഷ	(<i>kṣa</i>)
ക	+	ഃ	+	ക	→	കക	(<i>kka</i>)
ജ	+	ഃ	+	ണ	→	ജ്ഞ	(<i>jña</i>)
ട	+	ഃ	+	ട	→	ട്ട	(<i>ṭṭa</i>)
പ	+	ഃ	+	പ	→	പ്പ	(<i>ppa</i>)
ച	+	ഃ	+	ച	→	ച്ഛ	(<i>ccha</i>)
ബ	+	ഃ	+	ബ	→	ബ്ബ	(<i>bba</i>)
ന	+	ഃ	+	യ	→	ന്യ	(<i>nya</i>)
പ	+	ഃ	+	ര	→	പ്ര	(<i>pra</i>)
ശ	+	ഃ	+	വ	→	ശ്വ	(<i>śva</i>)

When the *candrakkala* sign is visibly shown in Malayalam, it indicates either the suppression of the preceding vowel or its replacement with a neutral vowel sound. This sound is often called “half-u” or *samvruthokaram*. In various orthographies this sound is typically spelled with either a vowel sign -u followed by *candrakkala* or a *candrakkala* alone. In vernacular orthographies, *candrakkala* can also be seen on an independent vowel letter or preceding an *anusvara*. In all cases, the *candrakkala* sign is represented by the character

U+0D4D MALAYALAM SIGN VIRAMA, which follows any vowel sign that may be present and precedes any *anusvara* that may be present. Implementions need to pay careful attention to correctly shape a Malayalam orthographic syllable when U+0D4D occurs in such locations. Examples are shown in *Table 12-35*.

Table 12-35. Candrakkala Examples

പാലു്	/pāl̥/ milk	0D2A, 0D3E, 0D32, 0D41, 0D4D
എന്നാ	/ənnā/ on which day? (vernacular)	0D0E, 0D4D, 0D28, 0D4D, 0D28, 0D3E
ഐശീലം	/aiśīl̥m/ than ice (vernacular)	0D10, 0D36, 0D40, 0D32, 0D4D, 0D02

Explicit Candrakkala. The sequence <C1, virama, ZWNJ, C2>, where C1 and C2 are consonants, may be used to request display with an explicit visible *candrakkala*, instead of the default conjunct form. See *Table 12-36* for an example. This convention is consistent with the use of this sequence in other Indic scripts.

Requesting Traditional Ligatures. The sequence <C1, ZWJ, virama, C2> may be used to request traditional ligatures, even if the current font defaults to the conjuncts appropriate for the reformed orthography. When such sequences occur, a closed or cursively connected ligature should be displayed, if available. See *Table 12-36* for examples. This convention is consistent with the use of this sequence in some other Indic scripts, such as Kannada, Oriya, and Telugu.

Requesting Open Forms of Conjuncts. The sequence <C1, ZWNJ, virama, C2> may be used to request open ligatures or those used in the reformed orthography, even if the current font defaults to the conjuncts appropriate for the traditional orthography. When such sequences occur, an open or disconnected conjunct form should be displayed, if available. See *Table 12-36* for examples. Note that such sequences are defined for Malayalam only, and are left undefined for other Indic scripts.

Table 12-36. Use of Joiners in Malayalam

ക + ്	+ റ	→ ക്ര or ക്ര	(kra)
സ + ്	+ ക	→ സ്ക or സ്ക	(ska)
ത + ്	+ സ	→ തസ or ത്സ	(tsa)
ഴ + ്	+ വ	→ ഴ or ഴ or ഴവ	(lva)
യ + ്	+ യ	→ യ്യ	(yya)
ക + ് + [ZWJ]	+ റ	→ ക്കര	(kra)
ക + [ZWJ] + ്	+ റ	→ ക്ര	(kra)
സ + [ZWJ] + ്	+ ക	→ സ്ക	(ska)

Table 12-36. Use of Joiners in Malayalam (Continued)

ത + ZW + ̣ + ന → ത്ന	(<i>tsa</i>)
ഴ + ZW + ̣ + വ → ഴ	(<i>lva</i>)
ക + ZW + ̣ + റ → ക്ര	(<i>kra</i>)
ഴ + ZW + ̣ + വ → ഴ	(<i>lva</i>)
യ + ZW + ̣ + യ → യ്യ	(<i>yya</i>)

Anusvara. The *anusvara* can be seen multiple times after vowels, whether independent letters or dependent vowel signs, as in $\text{ഇ} \text{ൗ} \text{ൗ} \text{ൗ} \text{ൗ} \text{ൗ}$ <0D08, 0D02, 0D02, 0D02, 0D02>. Vowel signs can also be seen after digits, as in 3550ൗ <0033, 0035, 0035, 0D3E, 0D02>. More generally, rendering engines should be prepared to handle Malayalam letters (including vowel letters), digits (both European and Malayalam), U+002D HYPHEN-MINUS, U+00A0 NO-BREAK SPACE and U+25CC DOTTED CIRCLE as base characters for the Malayalam vowel signs, U+0D4D MALAYALAM SIGN VIRAMA, U+0D02 MALAYALAM SIGN ANUSVARA, and U+0D03 MALAYALAM SIGN VISARGA. They should also be prepared to handle multiple combining marks on those bases.

Dot Reph. U+0D4E MALAYALAM LETTER DOT REPH is used to represent the dead consonant form of U+0D30 MALAYALAM LETTER RA, when it is displayed as a dot or small vertical stroke above the consonant that follows it in logical order. It has the character properties of a letter rather than those of a combining mark, but special behavior is required in implementations. Conceptually, *dot reph* is analogous to the sequence <*ra*, *virama*> which, in many Indic scripts, is rendered as a *reph* mark over the following consonant. This same behavior is expected for *dot reph*: it should be rendered as a mark over the following consonant. In standard Malayalam, the sequence <*ra*, *virama*> would normally occur only within the sequence <*ra*, *virama*, *ya*>, which should be rendered as the nominal form of *ra* with a conjoining form of *ya*.

The sequence <*ra*, *virama*, ZWJ> is not used to represent the *dot reph*, because that sequence has considerable preexisting usage to represent the *chillu* form of *ra*, prior to the encoding of the *chillu* form as a distinct character, U+0D7C MALAYALAM LETTER CHILLU RR.

The Malayalam *dot reph* was in common print usage until 1970, but has fallen into disuse. Words that formerly used *dot reph* on a consonant are now spelled instead with a *chillu-rr* form preceding the consonant. (See the following discussion of *chillu* characters.) The *dot reph* form is predominantly used by those who completed elementary education in Malayalam prior to 1970.

Chillu Forms. The nine characters, U+0D54..U+0D56 and U+0D7A..U+0D7F, encode dead consonants (those without an inherent vowel) known as *chillu* or *cillakṣaram*. In Malayalam language text, *chillu* forms never start a word. *Chillu-nn*, *-n*, *-rr*, *-l*, and *-ll* are

quite common; *chillu-k* is relatively rare in contemporary usage; *chillu-m*, *-y*, and *-lll* are found only in historical texts.

For backward-compatibility issues regarding the representation of *chillu* forms, see the discussion of legacy *chillu* sequences later in this section.

Although *chillus* are typically written alone, they may graphically behave like ordinary consonant letters. See *Table 12-37* for examples of conjuncts involving *chillus*. The *chillu*-involving conjuncts are encoded graphically: the graphic component bearing the ligated *chillu* tail is analyzed as a *chillu* character, and then stacking or ligating between characters is requested by U+0D4D MALAYALAM SIGN VIRAMA. Dependent signs such as vowel signs and *candrakkala* can be applied to both stand-alone *chillus* and *chillu*-involving conjuncts, just as they are applied to ordinary consonant letters and conjuncts.

Among the examples shown in *Table 12-37*, only the second conjunct, റ്റ (/*n̄*ta/), is used in modern Malayalam text. See “Special Cases Involving *rra*” later in this section for how to deal with the contrast between this conjunct and a phonetically related side-by-side form, റ്ററ.

Table 12-37. Malayalam Conjuncts Involving *Chillus*

ന്ന്	0D7A <i>chillu nn</i> , 0D4D <i>virama</i> , 0D28 <i>na</i>	/ <i>n̄</i> na/
ന്റ	0D7B <i>chillu n</i> , 0D4D <i>virama</i> , 0D31 <i>rra</i>	/ <i>n̄</i> ta/
ൻ	0D28 <i>na</i> , 0D4D <i>virama</i> , 0D7B <i>chillu n</i>	/ <i>n̄</i> n/
ല്	0D7D <i>chillu l</i> , 0D4D <i>virama</i> , 0D2A <i>pa</i>	/ <i>l̄</i> pa/
ല്	0D7E <i>chillu ll</i> , 0D4D <i>virama</i> , 0D35 <i>va</i>	/ <i>l̄</i> va/

U+0D3B MALAYALAM SIGN VERTICAL BAR VIRAMA is not used to form *chillus*. It only represents a vowel-killing vertical stroke that is identifiable as a separate stroke, either striking through or placed above the modified letter.

Special Cases Involving *rra*. There are a number of textual representation and reading issues involving the letter *rra*. These issues are discussed here and tables of explicit examples are presented.

The letter റ *rra* is normally read /*r̄*a/. Repetition of that sound is naturally written by repeating the letter: ററ. Each occurrence can bear a vowel sign.

The same repetition of the letter *rra* as ററ is also used for /*t̄*ta/, which can be unambiguously represented by റ്റ. The sequence of two റ letters fundamentally behaves as a digraph in this instance. The digraph can bear a vowel sign in which case the digraph as a whole acts graphically as an atom: a left vowel part goes to the left of the digraph and a right vowel part goes to the right of the digraph. Historically, the side-by-side form was used until around 1960 when the stacked form began appearing and supplanted the side-by-side form.

As a consequence the graphical sequence ററ in text is ambiguous in reading. The reader must generally use the context to understand if ററ is read / r̥ara / or / tta /. It is only when a vowel part appears between the two റ that the reading cannot be / tta /. Note that similar situations are common in many other orthographies. For example, *th* in English can be a digraph (*cathode*) or two separate letters (*cathouse*); *gn* in French can be a digraph (*oignon*) or two separate letters (*gnome*).

The sequence <0D31, 0D31> is rendered as ററ , regardless of the reading of that text. The sequence <0D31, 0D4D, 0D31> is rendered as റ̣ . In both cases, vowel signs are applied to each rendered base, as shown in Table 12-38.

Table 12-38. Malayalam / r̥ara / and / tta /

പാററ	0D2A 0D3E 0D31 0D31	/p̄atta/	cockroach
പാറ്റ	0D2A 0D3E 0D31 0D4D 0D31		
മാറൊലി	0D2E 0D3E 0D31 0D46 0D31 0D3E 0D32 0D3F	/m̄ättoli/	echo
മാറ്റൊലി	0D2E 0D3E 0D31 0D4D 0D31 0D4A 0D32 0D3F		
ബാറററി	0D2C 0D3E 0D31 0D31 0D31 0D3F	/b̄ättari/	battery
ബാറ്ററി	0D2C 0D3E 0D31 0D4D 0D31 0D31 0D3F		
സൂററ	0D38 0D42 0D31 0D31 0D31 0D4D	/s̄ūratt/	Surat, a town in Gujarat
സൂറ്റ്	0D38 0D42 0D31 0D31 0D4D 0D31 0D4D		
ടെംപററി	0D1F 0D46 0D02 0D2A 0D31 0D31 0D3F	/ṭempar̄ari/	temporary
ലെക്ചററോട്	0D32 0D46 0D15 0D4D 0D1A 0D31 0D31 0D4B 0D1F 0D4D	/lekcar̄ar̄oṭ/	to the lecturer

A very similar situation exists for the combination of റ chillu-n and റ rra . When used side by side, ററ can be read either / r̥ra / or / ṛṛa /, while stacked റ̣ is always read / ṛṛa />.

The sequence <0D7B, 0D31> is rendered as ററ , regardless of the reading of that text. The sequence <0D7B, 0D4D, 0D31> is rendered as റ̣ . In both cases, vowel signs are applied to each rendered base, as shown in Table 12-39.

Table 12-39. Malayalam / r̥ra / and / ṛṛa /

ആരേററ	0D06 0D7B 0D47 0D31 0D3E	/āṛṛo/	a proper name
ആരേറ്റ	0D06 0D7B 0D4D 0D31 0D4B		
എൻറേറൾ	0D0E 0D7B 0D31 0D4B 0D7E	/eṇṝoḷ/	enroll

Legacy Representations of Conjunct / ṛṛa /. Prior to Unicode 5.1 when <0D7B *chillu-n*, 0D4D *virama*, 0D31 *rra*> became the recommendation for the conjunct റ̣ /ṛṛa/ , two other

representations were already in use: <0D28 na, 0D4D virama, 0D31 rra> and <0D28 na, 0D4D virama, 200D ZWJ, 0D31 rra>. All three representations are widespread because implementations have been slow to adopt the recommended representation.

Implementations should treat <na, virama, rra> in existing text as equivalent to the recommended representation for the conjunct റ്റ, <chillu-n, virama, rra>. Newly generated text should only use the recommended representation.

The other legacy representation <na, virama, ZWJ, rra> conflicts with the legacy representation of the side-by-side form റ്ററ (see “Legacy Chillu Sequences” later in this section). Therefore, implementations should treat <na, virama, ZWJ, rra> as a representation of the stacked form റ്റ only if they know this sequence is not used to represent the side-by-side form റ്ററ.

Legacy Chillu Sequences. Prior to Unicode Version 5.1, the representation of text with *chillu* forms was problematic, and not clearly described in the text of the standard. Because older data will use different representation for *chillu* forms, implementations must be prepared to handle both kinds of data. For *chillu* forms considered in isolation, the following table shows the relationship between their representation in Version 5.0 and earlier, and the recommended representation starting with Version 5.1. Note that only the five *chillu* forms listed in Table 12-40 were specified in the standard before Version 5.1, and thus were represented in legacy text by <virama, ZWJ> sequences. Other *chillu* forms in Malayalam are only represented as atomically encoded *chillu* characters.

Table 12-40. Legacy Encoding of Malayalam Chillus

Visual	Legacy Representation (5.0)	Preferred Representation
ൺ	NNA, VIRAMA, ZWJ 0D23, 0D4D, 200D	0D7A MALAYALAM LETTER CHILLU NN
ൻ	NA, VIRAMA, ZWJ 0D28, 0D4D, 200D	0D7B MALAYALAM LETTER CHILLU N
ർ	RA, VIRAMA, ZWJ 0D30, 0D4D, 200D	0D7C MALAYALAM LETTER CHILLU RR
ൽ	LA, VIRAMA, ZWJ 0D32, 0D4D, 200D	0D7D MALAYALAM LETTER CHILLU L
ൾ	LLA, VIRAMA, ZWJ 0D33, 0D4D, 200D	0D7E MALAYALAM LETTER CHILLU LL

Malayalam Numbers and Punctuation

Archaic Numbers. The archaic numbering system for Malayalam included numbers for 10, 100, and 1000, as well as signs for fractions. Many Malayalam-specific fraction signs are encoded in the Malayalam block. Malayalam also made use of the fraction signs for one quarter, one half, and three quarters encoded in the Common Indic Number Forms block.

Date Mark. The *date mark* is used only for the day of the month in dates; it is roughly the equivalent of “th” in “June 5th.” While it has been used in modern times it is not seen as much in contemporary use.

Punctuation. *Danda* and *double danda* marks as well as some other unified punctuation used with Malayalam are found in the Devanagari block; see *Section 12.1, Devanagari*.