Proposal for a Devanagari Script Root Zone Label Generation Rule-Set (LGR)

LGR Version: 3.0

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1 General Information/ Overview/ Abstract

This document lays down the Label Generation Rule Set for Devanagari script. Three main components of the Devanagari Script LGR i.e. Code point repertoire, Variants and Whole Label Evaluation Rules have been described in detail here. All these components have been incorporated in a machine-readable format in the accompanying XML file named "Proposed-LGR-Deva-20180429.xml".

2 Script for which the LGR is proposed

ISO 15924 Code: Deva

ISO 15924 Key N°: 315

ISO 15924 English Name: Devanagari (Nagari)

Latin transliteration of native script name: dévanâgarî

Native name of the script: देवनागरी

Maximal Starting Repertoire [MSR] version: 2

3 Background on Script and Principal Languages Using It

The script called Nagari or Devanagari is written from left to right. Historically it derives from the Brahmi alphabet of the Ashokan inscriptions. Devanagari is currently used for 11 out of 22 scheduled languages of India (Boro/Bodo, Dogri, Hindi, Kashmiri, Konkani, Maithili, Marathi, Nepali, Sanskrit, Santali and Sindhi) and around 45 other languages especially the related Indo-Aryan languages: Bagheli, Bhili, Bhojpuri, Himachali dialects, Magahi, Newar and Rajasthani and its dialects: Marwari, Mewati, Shekhawati, Bagri, Dhundhari, Harauti and Wagdi. Closely associated with Sanskrit and Prakrit, it is an alternative script for Kashmiri (by Hindu speakers), Sindhi and Santali. It is growing popular in use by speakers of tribal languages of Arunachal Pradesh, Bihar, Chattisgarh, Jharkhand, Madhya Pradesh and Andaman & Nicobar Islands. The script is also used in Fiji to represent Fiji Hindi. Hindi is also a language of communication in Mauritius, Malaysia, England, Canada, South Africa, Indonesia as well as emigrant communities around the world. Nepali is the official language of Nepal as well as one of the official languages of the state of Sikkim in India. It is spoken by over 30 million people.

Devanagari is used by over 120 languages both in India and in South-east-Asia.

3.1 The Evolution of the Script

It is well-known that Devanagari has evolved from the parent script Brahmi, with its earliest historical form known as Aśokan Brahmi, traced to the 4th century B.C. Brahmi was deciphered by Sir James Prinsep in 1837. The study of Brahmi and its development has shown that it has given rise to most of the scripts in India as well as in other countries viz. Sri Lanka, Myanmar, Kampuchea, Thailand, Laos, and Tibet to name a few.

The evolution of Brahmi into present-day Devanagari involved intermediate forms, common to other scripts such as Gupta, and its two generates – Siddaṃ and Śāradā in the north and Grantha and Kadamba in the South. Devanagari can be said to have developed from the Kutila script, a descendant of the Gupta script, in turn a descendent of Brahmi. The word "kutila", meaning ‘crooked’, was used as a descriptive term to characterize the curving shapes of the script, compared to the straight lines of Brahmi. This inheritance is the reason for some of the characters across the scripts that will be considered under the Neo-Brahmi GP to look similar to each other despite belonging to totally different code blocks.

A look at the development of Devanagari from Brahmi gives an insight into how the Indic scripts have come to be diversified: the handiwork of engravers and writers who used different types of strokes led to different regional styles. The development of the script is outlined below. Figure 1: Pictorial depiction of Evolution of Devanagari illustrates the stages in the evolution of the script[1].

Period	Description
300 BCE	Mauryan: Early Brahmi form in the Asokan edicts. Some scholars believe that Brahmi itself evolved from "kharoshthi" a script written right to left.
200 CE	Kushan/Satavahana Dynasties.
400 CE	Gupta Dynasty
600 CE	Yasodharman
800 CE	Origins of the present day Nagari Script. Vardhana dynasty in the North and Pallava period in the South.
900 CE	The period of the Chalukyas and Rashtrakutas
1100 CE	Continuation of the Chalukya Rule
1300 CE	Yadavas in the north and Kakatiyas in the south.
1500 CE	The Vijayanagar empire.

Table 1: Evolution of Devanagari

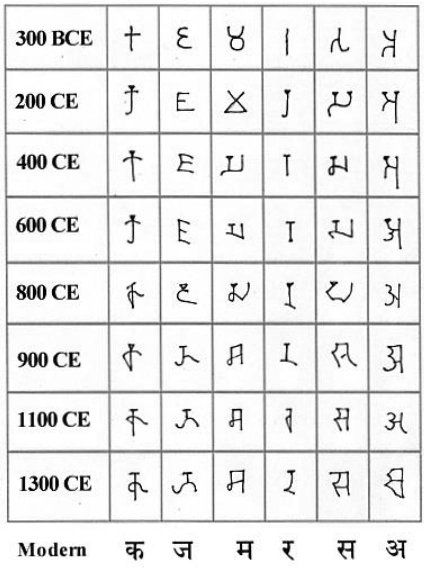


Figure 1: Pictorial depiction of Evolution of Devanagari

[1] http://www.acharya.gen.in:8080/sanskrit/script_dev.php

3.2 Languages considered

Devanagari script is used by over 120 languages which makes it one of the most used script in the world. The languages using Devanagari as their primary script belong to varying geo-political scenarios as given below.

- designated as official (scheduled) languages of some countries
- used by communities living in urban areas
- used by communities living in rural yet accessible areas
- used by communities living in far-flung areas which are not easily connected either by roads or by communication mechanisms.

The information about the languages which are part of official (scheduled) languages of some countries was easily available. The information of languages which are used by communities living in urban areas was also easily obtainable. There was some effort needed to cover the languages which are spoken by communities living in rural yet accessible areas. However, it was quite difficult to cover rest of the languages being spoken by the communities living in remote tribal areas which are generally not connected by road or by communication means. Defining the scope of language coverage was hence essential to limit the scope of the work to be undertaken for analysis of Devanagari LGR.

NBGP decided to employ “Expanded Graded Intergenerational Disruption Scale” [EGIDS] which is designed to measure status of the languages of the world in terms of endangerment or development. The EGIDS consists of 13 levels with each higher number on the scale representing a greater level of disruption to the intergenerational transmission of the language. NBGP decided to accommodate all the languages belonging to EGIDS Scale 1 to 4 for its analysis which represents languages in one form or the other are still in usage. Following are the descriptions[2] of those scales.

Scale	Label	Description
1	National	The language is widely used between nations in trade, knowledge exchange, and international policy.
2	Provincial	The language is used in education, work, mass media, and government at the national level.

[2] https://www.ethnologue.com/about/language-status

3	Wider Communication	The language is used in education, work, mass media, and government within major administrative subdivisions of a nation.
4	Educational	The language is in vigorous use, with standardization and literature being sustained through a widespread system of institutionally supported education.

Languages belonging to Level 5 and onwards are not in modern usage.

Below is the tabular representation of the languages that have been considered for the Devanagari LGR.

EGIDS Scale 1	**EGIDS Scale 2**	**EGIDS Scale 3**	**EGIDS Scale 4**
Hindi Nepali	Konkani Maithili Marathi Sindhi	Bhatri Halbi Kinnauri Kukna Panchpargania Sadri Wagdi	Bhojpuri Chhattisgarhi Dogri Kashmiri Limbu Magahi Sanskrit Santali Tamang, Eastern Avadhi Newar Saraiki[3]

Table 2: Languages considered under Devanagari LGR

Despite of being classified under EGIDS Scale 5, Boro language is also considered under the Devanagari LGR as it is one of the scheduled languages of India and is widely spoken.

[3] Though listed in EGIDS scale 4, Saraiki is not covered by the NBGP. As per ethnologue, Devanagari script is "no longer in use" by the Saraiki community.
Ref: https://www.ethnologue.com/language/skr

Apart from the above-mentioned languages, Braj, Dhundari, Mundari, Kharia have also been considered for the analysis.

3.2.1 Case of Sanskrit:

Sanskrit is generally perceived as an archaic language used only in ancient religious texts. However, it is worth noting that there is a quite vibrant and active user community of Sanskrit in India which practices Sanskrit on day to day basis. Sanskrit is still taught in schools under various State and Central educational boards. There is increasing use of Sanskrit on social media as well. The same is reflected in EGIDS scale where Sanskrit is categorized in Scale 4 indicating status of the language as “Educational”.

3.3 The structure of written Devanagari

Devanagari is an alphasyllabary and the heart of the writing system is the Akshar. It is this unit, which is instinctively recognized by users of the script. To understand the notion of akshar, a brief overview of the writing system is provided in this Section and the akshar itself will be treated in depth in Section5.4.

The writing system of Devanagari could be summed up as composed of the following:

3.3.1 The Consonants

Devanagari consonants have an implicit schwa[4] /ə/ included in them. As per traditional classification they are categorized according to their phonetic properties (especially in terms of place plus manner of articulation). There are 5 Varga groups (classes) and one non-Varga group. Each Varga, which corresponds to Stops, contains five consonants classified as per their properties. The first four consonants are classified on the basis of Voicing and Aspiration and the last is the corresponding nasal.

Varga	**Unvoiced**		**Voiced**		**Nasal**
	-Asp	+Asp	-Asp	+Asp	
Velar	क U+0915	ख U+0916	ग U+0917	घ U+0918	ङ U+0919

[4] Although representing the implicit vowel as /a/ is more correct orthographically, the schwa /ə/, although not part of the orthographic system has been used since the /a/ would be misunderstood and read as अ/आ/◌ा.

Palatal	च U+091A	छ U+091B	ज U+091C	झ U+091D	ञ U+091E
Retroflex	ट U+091F	ठ U+0920	ड U+0921	ढ U+0922	ण U+0923
Dental	त U+0924	थ U+0925	द U+0926	ध U+0927	न U+0928
Bi-labial	प U+092A	फ U+092B	ब U+092C	भ U+092D	म U+092E

Table 3: Varga classification of consonants

Non-Varga	य U+092F	र U+0930	ल U+0932	ळ U+0933	व U+0935	श U+0936	ष U+0937	स U+0938	ह U+0939

Table 4: Non-Varga consonants

3.3.2 The Implicit Vowel Killer: Halant[5]

All consonants have an implicit vowel (schwa) within them. A special sign is needed to denote that this implicit vowel is stripped off. This is known as the Halant"्" (U+094D).

The Halant thus joins two consonants and creates conjuncts, which can be generally from 2 to 4 consonant combinations. In rare cases it can join up to 5 consonants. However, the notion of maximum number of consonants joining to form one akshar is empirical. It is just an observation drawn from the words that have been observed till date. Given the confluence of languages happening in the Internet age, the possibility that one may want a generic Top Level Domain [gTLD] which may have more than the observed maximum cannot be ruled out. Hence, in the LGR work, this limit will not be enforced[6].

3.3.3 Vowels

Separate symbols exist for all Vowels, which are pronounced independently either at the beginning or after a vowel sound. To indicate a Vowel sound other than the implicit one, a Vowel sign (Matra) is attached to the consonant. Since the consonant has a built-in schwa, there are equivalent Matras for all vowels excepting the अ.

The correlation is shown as follows:

[5] Unicode (cf. Unicode 3.0 and above) prefers the term Virama. In this report both the terms have been used to denote the character that suppresses the inherent vowel.

[6]This can be the case when a foreign language word, which admits a large number of consonants, is transliterated into Devanāgarī

Vowel	Corresponding vowel sign (Matra)
अ U+0905	
आ U+0906	◌ा U+093E
इ U+0907	◌ि U+093F
ई U+0908	◌ी U+0940
उ U+0909	◌ु U+0941
ऊ U+090A	◌ू U+0942
ऋ U+090B	◌ृ U+0943
ए U+090F	◌े U+0947
ऐ U+0910	◌ै U+0948
ओ U+0913	◌ो U+094B
औ U+0914	◌ौ U+094C
ॳ U+0973	◌ऺ U+093A
ॴ U+0974	◌ऻ U+093B
ऍ/ॲ U+090D/ U+0972	◌ॅ U+0945

ॠ U+0960	◌ॄ U+0944
ऑ U+0911	◌ॉ U+0949
ॵ U+0975	◌ॏ U+094F
ॶ U+0976	◌ॖ U+0956
ॷ U+0977	◌ॗ U+0957

Table 5: Vowels with corresponding Matras

Marathi usesॲ (U+0972) instead ofऍ (U+090D).

3.3.4 The Anusvara (◌ं - U+0902)

The Anusvara represents a homorganic nasal. It replaces a conjunct group of a Nasal Consonant + Halant + Consonant belonging to that particular varga. Before a non-varga consonant the Anusvara represents a nasal sound. Modern Hindi, Marathi and Konkani prefer the Anusvara to the corresponding Half-nasal:

सन्त vs. संत /sənt/saint

U+0938 U+0928 U+094D U+0924 vs. U+0938 U+0902 U+0924

चम्पा vs. चंपा /tʃəmpa/

U+091A U+092E U+094D U+092A U+093E vs. U+091A U+0902 U+092A U+093E

3.3.5 Nasalization: Candrabindu (◌ँ - U+0901)

Candrabindu denotes nasalization of the preceding vowel as in आँख/ãkh/eye (U+0906 U+0901 U+0916). Present-day Hindi users tend to replace the Candrabindu by the Anusvara.

3.3.6 Nukta (़ - U+093C)[7]

The nukta sign is placed below a certain number of consonants to represent sounds found only in words borrowed from Perso-Arabic. It is pre-dominantly used in this manner in Bodo, Hindi, Kashmiri, Maithili, Santali, Sindhi and Tamang. It can be adjoined to "क"(U+0915), "ख"(U+0916), "ग"(U+0917),"ज"(U+091C) and "फ"(U+092B) to show that words having these consonants with a nukta are to be pronounced in the Perso-Arabic style.

e.g. फ़िरोज़ /firoz/ (U+092B U+093C U+093F U+0930 U+094B U+091C U+093C)

It is also placed under "ड"(U+0921) and "ढ"(U+0922) to indicate flapped sounds

बढ़ /bədh/(U+092C U+0922 U+093C)

Central Hindi Directorate, Ministry of HRD, Government of India Web Publication [109]"DEVANĀGARĪ ALPHABET AND ITS ROMANIZATION" clearly states such a use of Nukta in Hindi.

In Bodo it is adjoined to "ड"(U+0921) [110]. In Maithili it is adjoined to क(U+0915), ज(U+091C), "ड"(U+0921) and "ढ"(U+0922) [111]. In Sindhi, it is adjoined to "ख" (U+0916), "ग" (U+0917), "ज" (U+091C),"फ" (U+092B)"ड"(U+0921) and "ढ"(U+0922) [104].

In Kashmiri, it can also be adjoined to "च"(U+091A), "छ"(U+091B) and "ज" (U+091C) [108] to indicate the laterally released affricates.

च़ाय /čāy/ 'tea' (U+091A U+093C U+093E U+092F)

छ़ल /čhal/ 'wash; Imperative ' (U+091B U+093C U+0932)

पॊज़ /póz/ 'fact' (U+092A U+094A U+091C U+093C)

[7] The possible sets of consonants/vowels have been derived from various sources viz. Prior research carried out by Centre for Development of Advanced Computing's [C-DAC] Graphics Intelligence based Script Technologies [GIST] Research Labs (https://cdac.in/index.aspx?id=mlc_gist_about), Omniglot and inputs provided by various experts on-board the NBGP for specific languages. Only Omniglot references have been provided as they are available online.

Normally a Nukta is appended to Consonants. However, Santali language uses Nukta in a unique way. The nukta is adjoined to following vowels and vowel signs

a. आ (U+0906)

b. ओ (U+0913)

c. ◌ा(U+093E)

d. ◌ो(U+094B)

3.3.7 Visarga (◌ः - U+0903) and Avagraha (ऽ - U+093D)

The Visarga is frequently used in Sanskrit and represents a sound very close to /h/. दुःख /du:kh/ sorrow, unhappiness(U+0926 U+0941 U+0903 U+0916).

The Avagraha"ऽ" (U+093D) creates an extra stress on the preceding vowel and is used in Sanskrit texts. It is rarely used in other languages using Devanagari. In case of LGR, the Avagraha is not part of the repertoire as it is barred in the Maximal Starting Repertoire.

4 Overall Development Process and Methodology

Under the Neo-Brahmi Generation Panel, there are many different scripts belonging to separate Unicode blocks. Each of these scripts will be assigned a separate LGR; however Neo-Brahmi GP will ensure that the fundamental philosophy behind building those LGRs are all in sync with all other Brahmi derived scripts. This is the Devanagari LGR, which caters to multiple languages written using Devanagari belonging to EGIDS scale 1 to 4.

4.1 Guiding Principles

The NBGP adopts following broad principles for selection of code-points in the code-point repertoire across the board for all the scripts within its ambit.

4.1.1 Inclusion principles:

4.1.1.1 Modern usage:

Every character proposed should be in the everyday usage of a particular linguistic community. The characters which have been encoded in the Unicode for transcription purposes only or for archival purposes will not be considered for inclusion in the code-point repertoire.

4.1.1.2 Unambiguous use:

Every character proposed should have unambiguous understanding among the linguistic about its usage in the language.

4.1.2 Exclusion principles:

The main exclusion principle is that of External Limits on Scope. These comprise of protocols or standards which are pre-requisites to the Label Generation Rulesets. All further principles are in fact subsumed under these limitations but have been spelt out separately for the sake of clarity.

4.1.2.1 External Limits on Scope:

The code point repertoire for root zone being a very special case, up the ladder in the protocol hierarchies, the canvas of available characters for selection as a part of the Root Zone code point repertoire is already constrained by various protocol layers beneath it. Following three main protocols/standards act as successive filters:

i. The Unicode Chart:

Out of all the characters that are needed by the given script, if the character in question is not encoded in Unicode, it cannot be incorporated in the code point repertoire. Such cases are quite rare, given the elaborate and exhaustive character inclusion efforts made by Unicode consortium.

ii. IDNA Protocol:

Unicode being the character encoding standard for providing the maximum possible representation of a given script/language, it has encoded as far as possible all the possible characters needed by the script. However, the Domain name being a specialized case, it is governed by an additional protocol known as IDNA (Internationalized Domain Names in Applications). The IDNA protocol excludes some characters out of Unicode repertoire from being part of the domain names.

Example: Devanagari Letter Qa "क़" (U+0958) is not allowed to be a part of domain name. Its decomposed form, i.e. Devanagari Letter Ka followed by Devanagari Sign Nukta "क"(U+0915) +"़"(U+093C) can be used instead.

IDNA Protocol also excludes invisible characters Zero Width Non-Joiner (U+200C) and Zero Width Joiner (U+200D), as they require a CONTEXTJ rule. These are required in certain cases where a typical visual shape of an akshar is desired.

iii. Maximal Starting Repertoire:

The Root-zone LGR being a repertoire of the characters which are going to be used for creation of the root zone TLDs, which in turn are an even more specialized case of domain names, the ROOT LGR procedure introduces additional exclusions on IDNA allowed set of characters.

Example: Devanagari Sign Avagraha "ऽ" (U+093D) even if allowed by IDNA protocol, is not permitted in the Root Zone Repertoire as per the [MSR].

To sum up, the restrictions start off with admitting only such characters as are part of the code-block of the given script/language. This is further narrowed down by the IDNA Protocol and finally an additional filter in the form of Maximal Starting Repertoire restricts the character set associated with the given language even more.

4.1.2.2 No Punctuation Marks:

The TLDs being identifiers, punctuation markers present in Brahmi based languages such as Danda "।" (U+0964) and double Danda "॥" (U+0965) will not be included.

4.1.2.3 No Symbols and Abbreviations:

Abbreviations, weights and measures and other such iconic characters like Isshar"৺" (U+09FA), Abbreviation sign "॰" (U+0970) etc. will not be included.

4.1.2.4 No Rare and Obsolete Characters:

There are characters which have been added to Unicode to accommodate rare forms especially like DEVANAGARI LETTER VOCALIC RR"ॠ" (U+0960) and DEVANAGARI LETTER VOCALIC LL"ॡ" (U+0961) as well as their Matra forms "◌ॄ" (U+0944) and "◌ॣ" (U+0963). All such characters will not be included. This is in compliance with the Conservatism principle as laid down in the Root Zone LGR procedure.

4.1.2.5 No Stress Markers of Classical Sanskrit and Vedic:

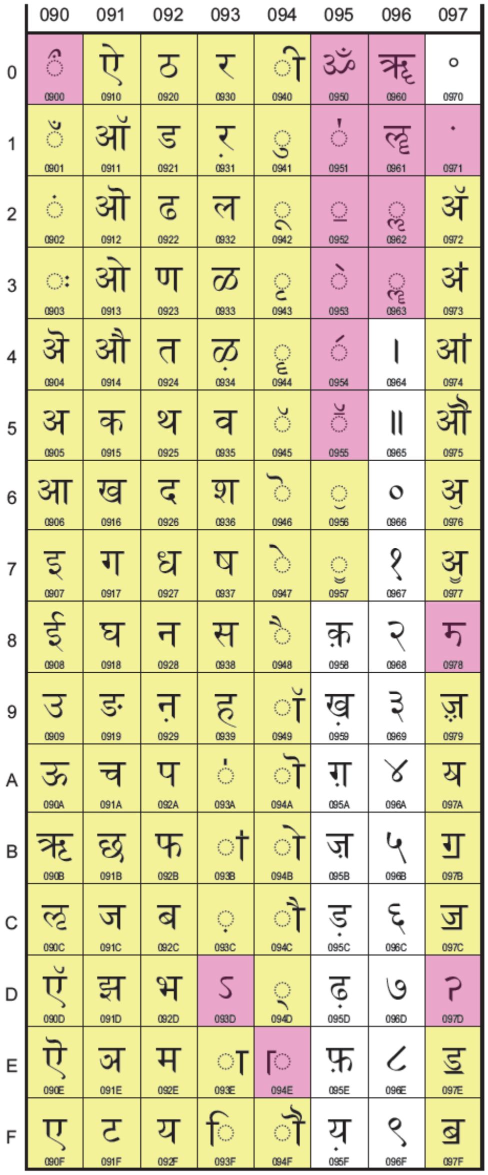
Stress markers for classical Sanskrit e.g. DEVANAGARI STRESS SIGN UDATTA "◌॑"(U+0951) and DEVANAGARI STRESS SIGN ANUDATTA "◌॒"(U+0952) will not be included. This is also in compliance with the Letter principle as laid down in the Root Zone LGR procedure.

5 Repertoire

Section 5.1 provides the section of the [MSR] applicable to the Devanagari script on which the Devanagari code-point repertoire is based.

Section 5.2details the code-point repertoire that the Neo-Brahmi Generation Panel [NBGP] proposes to be included in the Devanagari LGR.

5.1 Devanagari section of Maximal Starting Repertoire [MSR] Version 2



	090	091	092	093	094	095	096	097
0	◌ऀ 0900	ऐ 0910	ठ 0920	र 0930	◌ी 0940	ॐ 0950	ॠ 0960	॰ 0970
1	◌ँ 0901	ऑ 0911	ड 0921	ऱ 0931	◌ु 0941	◌॑ 0951	ॡ 0961	ॱ 0971
2	◌ं 0902	ऒ 0912	ढ 0922	ल 0932	◌ू 0942	◌॒ 0952	◌ॢ 0962	ॲ 0972
3	◌ः 0903	ओ 0913	ण 0923	ळ 0933	◌ृ 0943	◌॓ 0953	◌ॣ 0963	ॳ 0973
4	ऄ 0904	औ 0914	त 0924	ऴ 0934	◌ॄ 0944	◌॔ 0954	। 0964	ॴ 0974
5	अ 0905	क 0915	थ 0925	व 0935	◌ॅ 0945	◌ॕ 0955	॥ 0965	ॵ 0975
6	आ 0906	ख 0916	द 0926	श 0936	◌ॆ 0946	◌ॖ 0956	० 0966	ॶ 0976
7	इ 0907	ग 0917	ध 0927	ष 0937	◌े 0947	◌ॗ 0957	१ 0967	ॷ 0977
8	ई 0908	घ 0918	न 0928	स 0938	◌ै 0948	क़ 0958	२ 0968	ॸ 0978
9	उ 0909	ङ 0919	ऩ 0929	ह 0939	◌ॉ 0949	ख़ 0959	३ 0969	ॹ 0979
A	ऊ 090A	च 091A	प 092A	◌ऺ 093A	◌ॊ 094A	ग़ 095A	४ 096A	ॺ 097A
B	ऋ 090B	छ 091B	फ 092B	◌ऻ 093B	◌ो 094B	ज़ 095B	५ 096B	ॻ 097B
C	ऌ 090C	ज 091C	ब 092C	◌़ 093C	◌ौ 094C	ड़ 095C	६ 096C	ॼ 097C
D	ऍ 090D	झ 091D	भ 092D	ऽ 093D	◌् 094D	ढ़ 095D	७ 096D	ॽ 097D
E	ऎ 090E	ञ 091E	म 092E	◌ा 093E	◌ॎ 094E	फ़ 095E	८ 096E	ॾ 097E
F	ए 090F	ट 091F	य 092F	◌ि 093F	◌ॏ 094F	य़ 095F	९ 096F	ॿ 097F

Figure 2:Devanagari Code Page from [MSR]

Color convention[8]:

All characters that are included in the [MSR] - Yellow background

PVALID in IDNA2008 but excluded from the [MSR] - Pinkish background

Not PVALID in IDNA2008, or are ineligible for the root zone (digits, hyphen) - White background

[8] This document needs to be printed in color for this to be read correctly.

5.2 Code Point Repertoire:

For each of the code points, language references have been given in the last column titled "Reference". For the entire coverage of Devanagari code points, references of Hindi, Marathi, Sanskrit, Sindhi and Kashmiri have been given. Though only five representative languages have been chosen for referencing, they together cover all the code-points required for all the languages that NBGP has considered as given in 3.2.

Sr. No.	Unicode Code Point	Glyph	Character Name	Unicode General Category (gc)	Indic Syllabic Category	Example languages using the code-point (Not exhaustive list)	Language with lowest EGIDS scale using the code point	Reference
1.	0901	◌ँ	DEVANAGARI SIGN CANDRABINDU	Mn	Candrabindu	Bodo, Hindi, Kashmiri, Konkani, Maithili, Marathi, Nepali, Santali and Sanskrit	1 Hindi, Nepali	[0], [101], [102], [103]
2.	0902	◌ं	DEVANAGARI SIGN ANUSVARA	Mn	Anusvara (Bindu)	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103]
3.	0903	◌ः	DEVANAGARI SIGN VISARGA	Mc	Visarga	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103]
4.	0905	अ	DEVANAGARI LETTER A	Lo	Vowel	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104]

5.	0906	आ	DEVANAGARI LETTER AA	Lo	Vowel	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104]
6.	0907	इ	DEVANAGARI LETTER I	Lo	Vowel	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104]
7.	0908	ई	DEVANAGARI LETTER II	Lo	Vowel	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104]
8.	0909	उ	DEVANAGARI LETTER U	Lo	Vowel	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104]
9.	090A	ऊ	DEVANAGARI LETTER UU	Lo	Vowel	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104]
10.	090B	ऋ	DEVANAGARI LETTER VOCALIC R	Lo	Vowel	Hindi, Marathi, Sanskrit	1 Hindi	[0], [101], [102], [103]
11.	090D	ऍ	DEVANAGARI LETTER CANDRA E	Lo	Vowel	Hindi	1 Hindi	[0], [101]
12.	090E	ऎ	DEVANAGARI LETTER SHORT E	Lo	Vowel	Kashmiri	4 Kashmiri	[0], [105], [108]
13.	090F	ए	DEVANAGARI LETTER E	Lo	Vowel	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
14.	0910	ऐ	DEVANAGARI LETTER AI	Lo	Vowel	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]

15.	0911	ऑ	DEVANAGARI LETTER CANDRA O	Lo	Vowel	Hindi, Konkani, Marathi	1 Hindi	[0], [100], [108]
16.	0912	ऒ	DEVANAGARI LETTER SHORT O	Lo	Vowel	Kashmiri	4 Kashmiri	[0], [105], [108]
17.	0913	ओ	DEVANAGARI LETTER O	Lo	Vowel	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
18.	0914	औ	DEVANAGARI LETTER AU	Lo	Vowel	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
19.	0915	क	DEVANAGARI LETTER KA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
20.	0916	ख	DEVANAGARI LETTER KHA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
21.	0917	ग	DEVANAGARI LETTER GA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
22.	0918	घ	DEVANAGARI LETTER GHA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104]
23.	0919	ङ	DEVANAGARI LETTER NGA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103]
24.	091A	च	DEVANAGARI LETTER CA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]

25.	091B	छ	DEVANAGARI LETTER CHA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
26.	091C	ज	DEVANAGARI LETTER JA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
27.	091D	झ	DEVANAGARI LETTER JHA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104]
28.	091E	ञ	DEVANAGARI LETTER NYA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103]
29.	091F	ट	DEVANAGARI LETTER TTA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
30.	0920	ठ	DEVANAGARI LETTER TTHA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
31.	0921	ड	DEVANAGARI LETTER DDA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
32.	0922	ढ	DEVANAGARI LETTER DDHA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104]
33.	0923	ण	DEVANAGARI LETTER NNA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104]
34.	0924	त	DEVANAGARI LETTER TA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]

35.	0925	थ	DEVANAGARI LETTER THA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
36.	0926	द	DEVANAGARI LETTER DA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
37.	0927	ध	DEVANAGARI LETTER DHA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
38.	0928	न	DEVANAGARI LETTER NA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
39.	092A	प	DEVANAGARI LETTER PA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
40.	092B	फ	DEVANAGARI LETTER PHA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
41.	092C	ब	DEVANAGARI LETTER BA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
42.	092D	भ	DEVANAGARI LETTER BHA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
43.	092E	म	DEVANAGARI LETTER MA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
44.	092F	य	DEVANAGARI LETTER YA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]

45.	0930	र	DEVANAGARI LETTER RA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
46.	0932	ल	DEVANAGARI LETTER LA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
47.	0933	ळ	DEVANAGARI LETTER LLA	Lo	Consonant	Bodo, Konkani, Marathi, Nepali, Sanskrit	1 Nepali	[0], [102], [103]
48.	0935	व	DEVANAGARI LETTER VA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
49.	0936	श	DEVANAGARI LETTER SHA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
50.	0937	ष	DEVANAGARI LETTER SSA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104]
51.	0938	स	DEVANAGARI LETTER SA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
52.	0939	ह	DEVANAGARI LETTER HA	Lo	Consonant	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [104], [105], [108]
53.	093A	◌ऺ	DEVANAGARI VOWEL SIGN OE	Mn	Matra	Kashmiri	4 Kashmiri	[11], [105], [108]
54.	093B	◌ऻ	DEVANAGARI VOWEL SIGN OOE	Mc	Matra	Kashmiri	4 Kashmiri	[11], [105], [108]

55.	093C	◌़	DEVANAGARI SIGN NUKTA	Mn	Nukta	Bodo, Hindi, Kashmiri, Maithili, Santali, Sindhi	1 Hindi	[0], [101], [105], [108]
56.	093E	◌ा	DEVANAGARI VOWEL SIGN AA	Mc	Matra	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103]
57.	093F	◌ि	DEVANAGARI VOWEL SIGN I	Mc	Matra	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103]
58.	0940	◌ी	DEVANAGARI VOWEL SIGN II	Mc	Matra	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103]
59.	0941	◌ु	DEVANAGARI VOWEL SIGN U	Mn	Matra	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103]
60.	0942	◌ू	DEVANAGARI VOWEL SIGN UU	Mn	Matra	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103]
61	0943	◌ृ	DEVANAGARI VOWEL SIGN VOCALIC R	Mn	Matra	Hindi, Marathi, Sanskrit	1 Hindi	[0], [101], [102], [103]
62.	0945	◌ॅ	DEVANAGARI VOWEL SIGN CANDRA E = candra	Mn	Matra	Hindi, Konkani, Marathi, Sanskrit	1 Hindi	[0], [101], [100], [108]
63.	0946	◌ॆ	DEVANAGARI VOWEL SIGN SHORT E	Mn	Matra	Kashmiri	4 Kashmiri	[0], [105], [108]
64.	0947	◌े	DEVANAGARI VOWEL SIGN E	Mn	Matra	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [105], [108]

65.	0948	◌ै	DEVANAGARI VOWEL SIGN AI	Mn	Matra	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103]
66.	0949	◌ॉ	DEVANAGARI VOWEL SIGN CANDRA O	Mc	Matra	Hindi, Konkani, Marathi	1 Hindi	[0], [100], [108]
67.	094A	ऒ	DEVANAGARI LETTER SHORT O	Mc	Matra	Kashmiri	4 Kashmiri	[0], [105], [108]
68.	094B	◌ो	DEVANAGARI VOWEL SIGN O	Mc	Matra	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [105], [108]
69.	094C	◌ौ	DEVANAGARI VOWEL SIGN AU	Mc	Matra	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [105], [108]
70.	094D	◌्	DEVANAGARI SIGN VIRAMA	Mn	Halant / Virama	Most of the languages given in section 3.2	1 Hindi, Nepali	[0], [101], [102], [103], [105], [108]
71.	094F	◌ॏ	DEVANAGARI VOWEL SIGN AW	Mc	Matra	Kashmiri	4 Kashmiri	[0], [105], [108]
72.	0956	◌ॖ	DEVANAGARI VOWEL SIGN UE	Mn	Matra	Kashmiri	4 Kashmiri	[11], [105], [108]
73.	0957	◌ॗ	DEVANAGARI VOWEL SIGN UUE	Mn	Matra	Kashmiri	4 Kashmiri	[11], [105], [108]
74.	0972	ॲ	DEVANAGARI LETTER CANDRA A	Lo	Vowel	Konkani, Marathi,	2 Konkani, Marathi	[9], [100], [108]
75.	0973	ॳ	DEVANAGARI LETTER OE	Lo	Vowel	Kashmiri	4 Kashmiri	[11], [105], [108]
76.	0974	ॴ	DEVANAGARI LETTER OOE	Lo	Vowel	Kashmiri	4 Kashmiri	[11], [105], [108]

77.	0975	ॵ	DEVANAGARI LETTER AW	Lo	Vowel	Kashmiri	4 Kashmiri	[11], [105], [108]
78.	0976	ॶ	DEVANAGARI LETTER UE	Lo	Vowel	Kashmiri	4 Kashmiri	[11], [105], [108]
79.	0977	ॷ	DEVANAGARI LETTER UUE	Lo	Vowel	Kashmiri	4 Kashmiri	[11], [105], [108]
80.	097B	ॻ	DEVANAGARI LETTER GGA	Lo	Consonant	Sindhi	2 Sindhi	[8], [104]
81.	097C	ॼ	DEVANAGARI LETTER JJA	Lo	Consonant	Sindhi	2 Sindhi	[8], [104]
82.	097E	ॾ	DEVANAGARI LETTER DDDA	Lo	Consonant	Sindhi	2 Sindhi	[8], [104]
83.	097F	ॿ	DEVANAGARI LETTER BBA	Lo	Consonant	Sindhi	2 Sindhi	[8], [104]

Table 6: Code point repertoire

Apart from the above individual code-points, the Neo-Brahmi Generation Panel also proposes some specific sequences which enable conditional inclusion of the "DEVANAGARI LETTER RRA" in the repertoire for enabling inclusion of “Eyelash Reph”[9] construct.

Sr. No.	**Unicode Code Points**	**Sequence**	**Character Names**	**Unicode General Category (gc)**	**Example languages using the code-point (Not exhaustive list)**	**Reference**
1.	0931 094D 092F	ऱ्य	DEVANAGARI LETTER RRA DEVANAGARI SIGN VIRAMA DEVANAGARI LETTER YA	Lo Mn Lo	Konkani, Marathi, Nepali	[106], [107]

[9] Unicode uses term “Eyelash Ra” instead. Since the construct that is formed by this sequence is a special form of Reph (which is otherwise formed by Normal Ra U+0930), the term “Reph” is used.

2.	0931 094D 0939	ऱ्ह	DEVANAGARI LETTER RRA DEVANAGARI SIGN VIRAMA DEVANAGARI LETTER HA	Lo Mn Lo	Konkani, Marathi, Nepali	[106], [107]

Table 7: Sequences

5.3 Code points not included:

Following code points have not been included in the repertoire.

Sr. No.	Unicode Code Point	Glyph	Character Name	Reason for exclusion
1.	U+0904	ऄ	DEVANAGARI LETTER SHORT A	Usage unknown. Not required explicitly by any language.
2.	U+090C	ऌ	DEVANAGARI LETTER VOCALIC L	Not in modern usage. Excluded as per conservatism principle.
3.	U+0929	ऩ	DEVANAGARI LETTER NNNA	Not required in any spoken language. Required only for transcribing Dravidian alveolar n.
4.	U+0934	ऴ	DEVANAGARI LETTER LLLA	Not required in any spoken language. Required only for transcribing Dravidian l.
5.	U+0944	◌ॄ	DEVANAGARI VOWEL SIGN VOCALIC RR	Not in modern usage. Excluded as per conservatism principle.
6.	U+0979	ॹ	DEVANAGARI LETTER ZHA	Not required in any spoken language. Required only in transliteration of Avestan.
7.	U+097A	ॺ	DEVANAGARI LETTER HEAVY YA	Usage unknown. Not required explicitly by any language.

5.4 Structural Formation of Devanagari:

All the languages written in Brahmi derived scripts follow a particular way of formation of its words, known as "akshar". In the next section there are detailed akshar formation rules as applicable to representation of "Hindi" language when written in Devanagari Script. These rules need slight additions for different languages written in Devanagari in terms of

- Character addition/deletion (e.g. Nukta [U+093C] character is applicable for Hindi but not Marathi)

- Presence or absence of a particular rule (e.g. Eyelash Reph construct is required in Marathi, Konkani and Nepali but not in Hindi).

It is worth noting that the rules required for accommodation of additional languages in Devanagari ruleset apart from those required for Hindi are never in conflict with one another.

In Section 7, the Whole Label Evaluation (WLE) rules are given which cover all the languages under the purview of the NBGP for Devanagari script.

5.5 Akshar formation rules for Hindi:

This section details the Akshar formation rules as applicable to Hindi. The first section lists the categories of the characters in the form of variables. In the rules, instead of their descriptive names, the variable names are used. The second section lists four operators along with their functions which are assumed while specifying the rules. The following two sections describe the two major categories of the Akshar formations first of which begins with the vowels and the second one with the consonants. These rules are based on an Indian Standard (IS 13194:1991) popularly known as "Indian Script Code for Information Interchange" [ISCII].

5.5.1 Variables involved

Dash	→ Hyphen -
Digit	→ Indo-Arabic digits [0-9]
C	→ Consonant
M	→ Matra
V	→ Vowel
B	→ Anusvara (Bindu)
D	→ Candrabindu
X	→ Visarga
H	→ Halant / Virama
N	→ Nukta

5.5.2 Operators used:

Symbol	Function
|	Alternative
[ ]	Optional
*	Variable Repetition
( )	Sequence Group

Table 8: Symbol functions

In what follows, the Vowel Sequence and the Consonant Sequence pertinent to Devanagari, when used to write Hindi, are given.

5.5.3 The Vowel Sequence

A vowel sequence begins with a vowel. It may be optionally followed by an Anusvara (B), Candrabindu (D) or a Visarga (X). The number of B, D or X which can follow a V in Devanagari are restricted to one.

The possibility of a Visarga following a Candrabindu or Anusvara is ruled out, since it is used only in Vedic and in Bengali script.

The vowel sequence in Hindi is therefore V [B |D | X]

Examples:

Sequence Description	Sequence	Example	Constituting characters
Vowel	V	अ /a/ U+0905	
Vowel + Anusvara	V[B]	अं /aṁ/ U+0905 U+0902	अ ◌ं U+0905 U+0902
Vowel + Candrabindu	V[D]	अँ /aṃ/ U+0905 U+0901	अ ◌ँ U+0905 U+0901
Vowel + Visarga	V[X]	अः /aḥ/ U+0905 U+0903	अ ◌ः U+0905 U+0903

Table 9

5.5.4 Consonant Sequence

A consonant sequence begins with a consonant. It may be optionally followed by a Nukta (N), Matra (M), Anusvara (B), Candrabindu (D), Visarga (X) or a Halant (H). The number of instances of these characters occurring after a consonant is restricted to one. There is a possibility of further extension of the Consonant sequence after the N, M and H. Each of these has been discussed in the following sections:

1. A single consonant (C)

(The consonant shall be treated as coterminous with the Consonant along with the Nukta sign wherever such a case is pertinent.)

Examples:

Sequence Description	Sequence	Example	Constituting characters
Consonant	C	क /ka/ U+0915	<single character>
Consonant + Nukta	C[N]	क़ /ḳa/	क ◌़ U+0915 U+093C

Table 10

2. A consonant optionally followed by dependent vowel sign/Matra [M] or Anusvara [D] Candrabindu [B] or Visarga[X] or Halant [H]

C [M|B|D|X|H]

Examples:

Sequence Description	Sequence	Example	Constituting characters
Consonant + Matra	C[M]	कि /ki/	क ◌ि U+0915 U+093F
Consonant + Anusvara	C[B]	कं /kaṁ/	क ◌ं U+0915 U+0902
Consonant + Candrabindu	C[D]	कँ /kaṃ/	क ◌ँ U+0915 U+0901

Consonant + Visarga	C[X]	कः /kaḥ/	क ◌ः U+0915 U+0903
Consonant + Halant	C[H]	क् /k/ (Pure Consonant)	क ◌् U+0915 U+094D

Table 11

2. A. A CM sequence can be optionally followed by D, B or X

(CM)[D|B|X]

Example:

Sequence Description	**Sequence**	**Example**	**Constituting characters**
Consonant + Matra + Anusvara	CM[B]	कीं /kīṁ/	क ◌ी ◌ं U+0915 U+0940 U+0902
Consonant + Matra + Candrabindu	CM[D]	काँ /kāṃ/	क ◌ा ◌ँ U+0915 U+093E U+0901
Consonant + Matra + Visarga	CM[X]	कीः /kīḥ/	क ◌ी ◌ः U+0915 U+0940 U+0903

Table 12

3. A sequence of consonants (up to 4) joined by Halant *3(CH)C

Example:

Sequence Description	**Sequence**	**Example**	**Constituting characters**
Consonant + Halant + Consonant + Halant + Consonant + Halant + Consonant	CHCHCHC	न्क्र्य /nkrya/	न्क्र्य U+0928 U+094D U+0915 U+094D U+0930 U+094D U+092F

Table 13

Subsets:

3.A. The combination may be followed by M, B, D or X

Example:

Sequence Description	Sequence	Example	Constituting characters
Consonant + Halant + Consonant + Matra	CHC[M]	क्की /kkī/	क्की U+0915 U+094D U+0915 U+0940
Consonant + Halant + Consonant + Anusvara	CHC[B]	क्कं /kkaṁ/	क्कं U+0915 U+094D U+0915 U+0902
Consonant + Halant + Consonant + Candrabindu	CHC[D]	क्कँ /kkaṃ/	क्कँ U+0915 U+094D U+0915 U+0901
Consonant + Halant + Consonant + Visarga	CHC[X]	क्कः /kkaḥ/	क्कः U+0915 U+094D U+0915 U+0903

Table 14

3. B. *3(CH)CM may be followed by a B, D or X

Example:

Sequence Description	Sequence	Example	Constituting characters
Consonant + Halant + Consonant + Matra + Anusvara	CHCM[B]	क्कीं /kkīṁ/	क्कीं U+0915 U+094D U+0915 U+0940 U+0902
Consonant + Halant + Consonant + Matra +Candrabindu	CHCM[D]	क्कीँ /kkīṃ/	क्कीँ U+0915 U+094D U+0915 U+0940 U+0901
Consonant + Halant + Consonant + Matra +Visarga	CHCM[X]	क्कीः /kkīḥ/	क्कीः U+0915 U+094D U+0915 U+0940 U+0903

Table 15

These are the basic akshar rules on which the overall Devanagari LGR is based. As languages other than Hindi are considered, some additional language specific characters and rules are introduced. There are some additional finer aspects to these rules as one takes into account the digits, punctuations and special standalone characters like Avagraha. Those aspects are not discussed here as the [MSR] on which the LGRs are supposed to be based, excludes those characters.

6 Variants

There are no characters/character sequences in Devanagari which can be created by using the characters permitted as per the [MSR] and look exactly alike. However, Devanagari has ample cases of confusingly similar variants. The NBGP categorizes these confusingly similar variants in two groups.

Group1: Confusing due to pure visual similarity

Group2: Confusing due to deviation from normally perceived character formations by larger linguistic community

As advised by ICANN, no cases belonging to Group 1 are proposed, as there is another panel (String similarity assessment panel) entrusted to deal with such cases. The "Table 20: Visual confusables" in "Appendix A: Visually confusable characters/sequences" lists them.

Cases which belong to Group 2, however, are proposed to be considered as variants. These cases are not of mere visual similarity as they involve some deviations from the widely accepted norms of Devanagari Akshar formations. These can cause confusion even to a careful observer and hence being proposed as variants. Following is the brief description of these variants followed by variants in Table 16 and Table 17.

6.1 Vowel/Vowel sign followed by Nukta:

Santali language has a unique requirement for Nukta character "◌़"(U+093C) positioning which is not common in other Devanagari based languages. Santali requires the Nukta character to follow certain Vowels and Matras. Complete representation of these Santali combinations necessitated the Whole Label Evaluation rules (given in the Section6.20)to be opened up for these specific cases. A regular non-Santali user mostly cannot even anticipate possibility of such a combination and can confuse it for something else.

This gives rise to a possibility of creation of certain labels which can be deceptively similar to a majority of the Devanagari user-base. Being a unique case of homographic similarity, following variants are being proposed.

Variant 1	Variant 2
आ U+0906	आ़ U+0906 U+093C
ओ U+0913	ओ़ U+0913 U+093C
◌ा U+093E	◌ा◌़ U+093E U+093C
◌ो U+094B	◌ो◌़ U+094B U+093C

Table 16: Proposed Variants - Set 1

6.2 Unique Vowels and Vowel Signs required for Kashmiri

Kashmiri when written in Devanagari script requires a unique set of Vowels and Vowel signs which only a Kashmiri speaker can understand. Majority of Devanagari users who are not conversant with Kashmiri can easily confuse them with some of the Vowels / Vowel signs which look similar to the Kashmiri ones. There are also cases where a Kashmiri Vowel / Vowel signs can be confused with certain Akshar formations. Hence, they are being proposed as variants.

Variant 1	Variant 2
ॳ U+0973	अं U+0905 U+0902
◌ऺ U+093A	◌ं U+0902
ॴ U+0974	आं U+0906 U+0902
◌ऻ U+093B	◌ा◌ं U+093E U+0902
ऎ U+090E	ऐ U+0910
◌ॆ U+0946	◌े U+0947
ॵ U+0975	औ U+0914
◌ॏ U+094F	◌ौ U+094C

Table 17: Proposed Variants - Set 2

6.3 Halant ending (Only a discussion, not proposed as variants):

Another case of deceptive similarity to a majority of the Devanagari user-base is of a word ending in Halant "्" (U+094D) vis-à-vis the same word without the final Halant. As the function of Halant is of a vowel killer, coming at the end, many users tend to ignore the phonetic effect of its presence/absence. Majority of the users would pronounce both the words in the same way, thereby creating a perception of (false) equivalence. However, there also exist some users which clearly require the final Halant to achieve the peculiar phonetic effect of a truncated implicit vowel sound in the end. These users make a clear distinction between two words (with and without the final Halant). It is for this reason; the final Halant is being accommodated in the Whole Label Evaluation rules for Devanagari.

In these cases, the presence or absence of final Halant is clearly visible, and there is no apparent case to make them variant pairs. Eventually, in the light of practical experience, future NBGP revision may assess if these cases need to be considered as variant pairs.

6.4 Variant Disposition:

As variants mentioned in both (Table 16 and Table 17) categories are of confusingly similar, albeit of a peculiar nature, it is proposed that they be considered of "blocked" nature.

There is no preference among these variants. Whichever label containing either of these variants is chosen earlier, the other one equivalent variant label should be blocked.

6.5 Cross-script Variants:

A cross-script variant, also sometimes referred to as "Whole Label confusable", is the variant case where one label in one script can be composed in such a way that it can resemble another entire label in a different script.

Every individual LGR under NBGP is supposed to provide a set of cross script variants it identifies with all other scripts under NBGP.

NBGP has ensured that not only the individual characters but also most of the akshar variations are taken into consideration during the Cross-script variant analysis of Devanagari with all the other scripts under NBGP. It was achieved by sharing a list of most (a word ‘most’ is used here as all the possible Consonant + Halant + Consonant+…. cases cannot be practically covered. Case of all the Devanagari “Consonant + Halant + Consonant” was included in the analysis.) of the akshar combinations with all the other script teams.

Devanagari script has a major set of possible cross-script variants only with the Gurmukhi script. Cases listed in Table 18 are of the variants that are proposed to be cross-script variants between Devanagari and Gurmukhi. Similarly, Table 19 has the cases proposed to be cross-script variants between Devanagari and Bengali.

It is to be noted that none of the combinations listed in Table 18 and Table 19 are termed to be equivalents of each other semantically or otherwise. They are only grouped based on possible visual confusability.

NBGP has ensured that Devanagari, Bengali and Gurmukhi LGR teams propose a same set of cross-script variants by meeting face-to-face on many occasions as well as through mail communications. The same set of cross-script variants (with Devanagari) is supposed to be found in the Bengali and Gurmukhi LGR documents.

Devanagari	**Gurmukhi**
◌ं U+0902	◌ਂ U+0A02
इ U+0907	ਙ U+0A19
उ U+0909	ਤ U+0A24
ग U+0917	ਗ U+0A17
घ U+0918	ਬ U+0A2C
ट U+091F	ਟ U+0A1F
ठ U+0920	ਠ U+0A20

ढ U+0922	ਫ U+0A2B
प U+092A	ਧ U+0A27
भ U+092D	ਮ U+0A2E
म U+092E	ਸ U+0A38
व U+0935	ਕ U+0A15
ह U+0939	ਵ U+0A35
□ U+093A	◌ਂ U+0A02
ि◌ U+093F	ਿ◌ U+0A3F
◌ी U+0940	◌ੀ U+0A40
◌ॅ U+0945	◌ੱ U+0A71
◌े U+0946	◌ੇ U+0A47

◌ॆ U+0946	◌ੋ U+0A4B
◌े U+0947	◌ੇ U+0A47
◌े U+0947	◌ੋ U+0A4B
◌ै U+0948	◌ੈ U+0A48
◌ॖ U+0956	◌ੁ 0A41
◌ॗ U+0957	◌ੂ 0A42
प्टि U+092A U+094D U+091F U+093F	ਇ U+0A07
प्टी U+092A U+094D U+091F U+0940	ਈ U+0A08
प्टे U+092A U+094D U+091F U+0947	ਏ U+0A0F
त्त U+0924 U+094D U+0924	ਜ U+0A1C

Table 18: Proposed Cross-script Devanagari-Gurmukhi Variants

Devanagari	Bengali

म U+092E	ম U+09AE
◌ि U+093F	◌ি U+09BF

Table 19: Proposed Cross-script Devanagari-Bengali Variants

In addition to above cases, Devanagari and Gurmukhi scripts have a possible set of cross-script variants which look similar but not similar enough to be recommended as cross-script variants. The "Table 21: Devanagari Cross-script confusables" in "Appendix B: Cross-script Confusables" lists them.

7 Whole Label Evaluation Rules (WLE)

This section provides the WLEs that are required by all the languages mentioned in section 3.2 when written in Devanagari Script. The rules have been drafted in such a way that they can be easily translated into the LGR specification.

Below are the symbols used in the WLE rules, for each of the "Indic Syllabic Category" as mentioned in the Table 6: Code point repertoire.

C	→	Consonant
M	→	Matra
V	→	Vowel
B	→	Anusvara (Bindu)
D	→	Candrabindu
X	→	Visarga
H	→	Halant / Virama
N	→	Nukta
S	→	Eyelash Reph (C1HC2) where C1 is 0931 (ऱ- DEVANAGARI LETTER RRA) H is 094D (◌् - DEVANAGARI SIGN VIRAMA) C2 is either - 092F (य - DEVANAGARI LETTER YA)

or 0939(ह - DEVANAGARI LETTER HA)

Below are the specific WLE rules:

1. N: must be preceded only by either of specific set of Cs, Vs and Ms

   The specific Cs are:

   a. क (U+0915)
   b. ख (U+0916)
   c. ग (U+0917)
   d. च (U+091A)
   e. छ (U+091B)
   f. ज (U+091C)
   g. ड (U+0921)
   h. ढ (U+0922)
   i. फ (U+092B)

   The specific Vs are:

   a. आ (U+0906)(Required in Santali language)
   b. ओ (U+0913)(Required in Santali language)

   The specific Ms are:

   a. ◌ा (U+093E) (Required in Santali language)
   b. ◌ो (U+094B) (Required in Santali language)

2. H: must be preceded by C or CN
3. M: must be preceded by C or CN
4. X: must be preceded by either of V, C, N or M
5. B: must be preceded by either of V, C, N or M

6. D: must be preceded by either of V, C, N or M
7. V: Can **NOT** be preceded by H (details in "Case of V preceded by H")

Case of Eyelash Reph:

In the WLE rules, there is no specific mention of the Eyelash Reph for two reasons:

1. As the U+0931 is added as a part of permissible sequences in Table 7: Sequences, it gets permitted only with the specific sequences.
2. The last characters of both the sequences of which the U+0931 is part, are consonants. As the Eyelash-Reph can take all the combinations as that of a consonant, no specific handling in terms of context rule is required.

Case of V preceded by H:

There could be cases involving multi-word domains where V may need to be allowed to follow an H

> e.g. आम्अचार */aːməchaːr/* (U+0906 U+092E U+094D U+0905 U+091A U+093E U+0930) (meaning: *Mango pickle*)

This is the case where two different words are joined together first of which ends in an H and the second word begins with a V. Some sections of the linguistic community require the explicit presence of H for full representation of the sound intended. However, by and large, the form of the first word without an H is considered enough for full representation of the sound intended for the first word.

This is a unique situation necessitated by the lack of hyphen, space or the Zero Width Non-joiner character in the permissible set of characters in the Root zone repertoire. Otherwise, V is never required to be allowed to follow an H. Permitting this may create a perceptive similarity among two labels (with and without H) for majority of the linguistic community, hence this is explicitly prohibited by the NBGP.

In future if required, depending on the prevailing requirements by the community, the future NBGP may consider revisiting this rule.

8 Contributors

NBGP Co-chairs: Dr. Udaya Narayan Singh, Mr. Mahesh D Kulkarni and Dr. Ajay Data

Following is the full list of NBGP members with their Language expertise.

Name	**Language Expertise**
Raiomond Doctor	English, Hindi, Marathi, Gujarati
Udaya Narayana Singh	Bengali, Maithili, Hindi, English
Mahesh D. Kulkarni	Marathi, Hindi
Ajay Data	Hindi
Akshat S. Joshi	Hindi, Marathi
Neha Gupta	Hindi
Nishit Jain	Hindi
Shantaram S. Warde Walawalikar	Konkani
Bal Krishna Bal	Nepali
Ganesh Murmu	Santali
Saroja Bhate	Sanskrit
Shambhu Kumar Singh	Maithili
Swarna Prabha Chainary	Bodo
Ghanashyam Nepal	Nepali
Kalyan Vasudeo Kale	Marathi
Shashi Pathania	Dogri
Prabhakar Pandey	Hindi
Balaram Prasain	Nepali
Rajiv Kumar	Hindi
Jay Paudyal	Hindi
Hempal Shrestha	Nepali, Newari

Suraj Adhikari	Nepali
Pawan Chitrakar	Nepali
Nirajan Parajuli	Nepali
Uttam Shrestha Rana	Nepali
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Vinay Murarka	Hindi
Mukesh Saini	Hindi
N. DeivaSundaram	Tamil
Rajib Chakraborty	Bangla (Bengali)
Gurpreet Singh Lehal	Panjabi
Santhosh Thottingal	Malayalam, Sourashtra, Tamil
Uma Maheshwar G	Telugu
Girish Chandra Mishra	Odia
K. C. Tikayat ray	Odia
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Basanta Kumar Panda	Odia
Arvind Bhandari	Gujarati
Chitrita Chatterjee	Multiple languages represented by members of IAMAI
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Gangadhar Panday	Telugu

Anivar A. Aravind	Malayalam
Shanmugam R	Tamil
Prasad PK	Malayalam
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In addition, following members externally gave inputs to NBGP for the respective languages/scripts.

Name	**Language/Script Expertise**
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Ajit Kumar	Awadhi, Braj Language
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Basil Kiro	Kharia Language
Biswa Limbu	Limbu Language
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Dinbandhu Mahto	Panchpargania Language
Dr. Birendra Kumar Soy	Mundari Language
Dr. Dinesh Kumar Shrivastav	Magahi Language
Dr. Harvinder Kaur	Gurmukhi Script
Dr. Laxmi Prasad Khatiwada	Nepali Language
Jagannath Singh	Panchpargania Language
Narendra Kumar Negi	Kinnauri Language
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Amar Tumyahang	Limbu Language
Amrit Yonjan	Tamang Language
Indra Kumar Tamang	Tamang Language
Dipika Sangma Narzary	Bodo Language
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Full Updated list of NBGP members is available at:
https://community.icann.org/display/croscomlgrprocedure/Neo-Brahmi+GP

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11 Appendix A: Visually confusable characters/sequences

Confusable 1	Confusable 2
क U+0915	क़ U+0915U+093C
ख U+0916	ख़ U+0916U+093C
ग U+0917	ग़ U+0917 U+093C
च U+091A	च़ U+091A U+093C
छ U+091B	छ़ U+091B U+093C
ज U+091C	ज़ U+091C U+093C
ड U+0921	ड़ U+0921 U+093C
ढ U+0922	ढ़ U+0922 U+093C
फ U+092B	फ़ U+092B U+093C

Table 20: Visual confusables

12 Appendix B: Cross-script Confusables

Devanagari script has a major set of possible cross-script confusables with the Gurmukhi script. The Table 21 lists them.

In addition to Gurmukhi, single instance of cross-script confusable is found with Bengali, Gujarati, Telugu, Kannada, Malayalam and Sinhala.

It is to be noted that none of the combinations listed in Table 21 are termed to be equivalents of each other semantically or otherwise. They are only grouped based on possible visual confusability.

At first, they may not look exactly the same, however, in the given context e.g. in browser bar as a part of a domain name, or as a single word where there is no surrounding text from the same script for distinguishing, they can create visual confusion.

A label can be considered to have a cross-script variant label only if "all" the constituent characters/aksharas have an equivalent confusable in the other script. If there is even one single character/akshara which does not have an equivalent visual confusable in other script, it essentially provides a visually distinguishability and hence a non-confusable string.

Devanagari confusable	Other script confusable	From script
◌ः U+0903	◌ઃ U+0A83	**Gujarati**
◌ः U+0903	◌ః U+0C03	**Telugu**
◌ः U+0903	◌ಃ U+0C83	**Kannada**
◌ः U+0903	◌ഃ U+0D03	**Malayalam**
◌ः U+0903	◌ඃ U+0A28	**Sinhala**

उ U+0909	ও U+0993	**Bengali**
घ U+0918	ঘ U+0998	**Bengali**
ठ U+0920	ਨ U+0A28	**Gurmukhi**
ठ U+0920	ਰ U+0A30	**Gurmukhi**
ड U+0921	ਡ U+0A21	**Gurmukhi**
ड U+0921	ਤ U+0A24	**Gurmukhi**
ढ U+0922	ਢ U+0A22	**Gurmukhi**
त U+0924	ਜ U+0A1C	**Gurmukhi**
य U+092F	ਧ U+0A27	**Gurmukhi**
◌ॅ U+0945	◌ঁ U+0981	**Bengali**

Table 21: Devanagari Cross-script confusables