

Title: Proposal to Encode the BAKHSHALI MINUS SIGN for Sharada
Source: Anshuman Pandey (pandey@umich.edu)
Status: Individual Contribution
Action: For consideration by UTC and WG2
Date: 2013-04-25

1 Introduction

This is a proposal to encode a new character in the Sharada block of the Universal Character Set (ISO/IEC 10646). Properties of the proposed character are:

GLYPH	CODE	CHARACTER NAME	GC	CCC	BIDI	MIRRORED	LINEBREAK
+	?	SHARADA BAKHSHALI MINUS SIGN	Sm	0	ES	N	PR

There is a request to reallocate recently-approved, but not yet encoded, Sharada characters within the block (see N4417 L2/13-074). If the request to reorder is approved, and if the present proposal is also approved, then SHARADA BAKHSHALI MINUS SIGN should be assigned to U+111CE.

2 Description

The + SHARADA BAKHSHALI MINUS SIGN is used in the *Bakhshali Manuscript*, a mathematical treatise written in Sharada, dated to the 2–4th centuries CE. It indicates a negative number or subtraction and is written after a number, eg. ३+ for ‘-3’. Detailed descriptions of the character are given by G. R. Kaye (1927), reproduced here in figures 7 and 8.

3 Character Data

Character Properties Character properties given in the data format of `UnicodeData.txt`:

```
111Cx;SHARADA BAKHSHALI MINUS SIGN;Sm;0;ES;;;;;N;;;;;
```

Linebreaking Properties Linebreaking properties given in the data format of `LineBreak.txt`:

```
111Cx;PR # SHARADA BAKHSHALI MINUS SIGN
```

Annotation to the Names List The following annotation is to be added to `NamesList.txt`:

```
@      Signs from the Bakhshali manuscript
111Cx  SHARADA BAKHSHALI MINUS SIGN
```

‘Confusables’

```
111Cx SHARADA BAKHSHALI MINUS SIGN ; 002B PLUS SIGN
```

4 References

Kaye, G. R. 1927. *The Bakhshālī Manuscript: A Study in Mediæval Mathematics*. Archaeological Survey of India, New Imperial Series, Vol. XLII. Parts I & II, Part III. Calcutta: Government of India Central Publication Branch.

Pandey, Anshuman. 2009. “Proposal to Encode the Sharada Script in ISO/IEC 10646”. N3595 L2/09-074R2. August 5, 2009. <http://std.dkuug.dk/JTC1/SC2/WG2/docs/n3595.pdf>

———. 2013. “Request to reallocate some recently-approved Sharada characters”. N4417 L2/13-074. April 25, 2013. <http://std.dkuug.dk/JTC1/SC2/WG2/docs/n4417.pdf>



Figure 1: Use of the BAKHSHALI MINUS SIGN in folio 1r of the manuscript (from Kaye 1927: 22).

[13r.]

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<table border="1" style="margin: auto;"> <tr><td>1</td><td>1</td><td>1</td><td>1</td></tr> <tr><td>1+</td><td>1+</td><td>1+</td><td>1+</td></tr> <tr><td>4</td><td>4</td><td>4</td><td>4</td></tr> </table>	1	1	1	1	1+	1+	1+	1+	4	4	4	4	gunitamjātam	<table border="1" style="margin: auto;"> <tr><td>81</td></tr> <tr><td>32</td></tr> </table>	81	32	. u . y .	<table border="1" style="margin: auto;"> <tr><td>8</td><td></td><td></td></tr> <tr><td></td><td>4</td><td>4</td></tr> </table>	8				4	4
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<p>phalam 81 phalam punānyam 8</p> <p>phalamkumkuma 8 udā</p> <p>gudapindāshṭabhārakam </p> <table border="1" style="margin: auto;"> <tr><td>8</td><td>2</td><td>5</td><td>4</td></tr> <tr><td>1</td><td>3</td><td>6</td><td>5</td></tr> </table>	8	2	5	4	1	3	6	5	<p>gunitamjātam</p> <table border="1" style="margin: auto;"> <tr><td>8</td></tr> <tr><td>1+</td></tr> <tr><td>4</td></tr> <tr><td>1+</td></tr> <tr><td>4</td></tr> <tr><td>1+</td></tr> <tr><td>4</td></tr> <tr><td>1+</td></tr> <tr><td>4</td></tr> </table>	8	1+	4	1+	4	1+	4	1+	4	<p>phalam 81 punapratyayam 0</p> <p>tribhāgashadbhāga 1+ pañchā</p> <p>kimsesham dattabhirbhavet 1+</p> <p>etatphalam 1+</p> <p>bhenadaśadronātprayojita</p>	<p>bhā</p> <p>32</p> <p>u</p>				
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<p>dvaitribhistukimlābhamkatthyatāmgunakottama</p>	<p>10</p>	<p>5</p>	<p>5</p>	<p>.</p>																				
<p>m 125 </p>																								

Figure 2: Use of the BAKHSHALI MINUS SIGN in a transliteration of folio 1r (from Kaye 1927: 105).

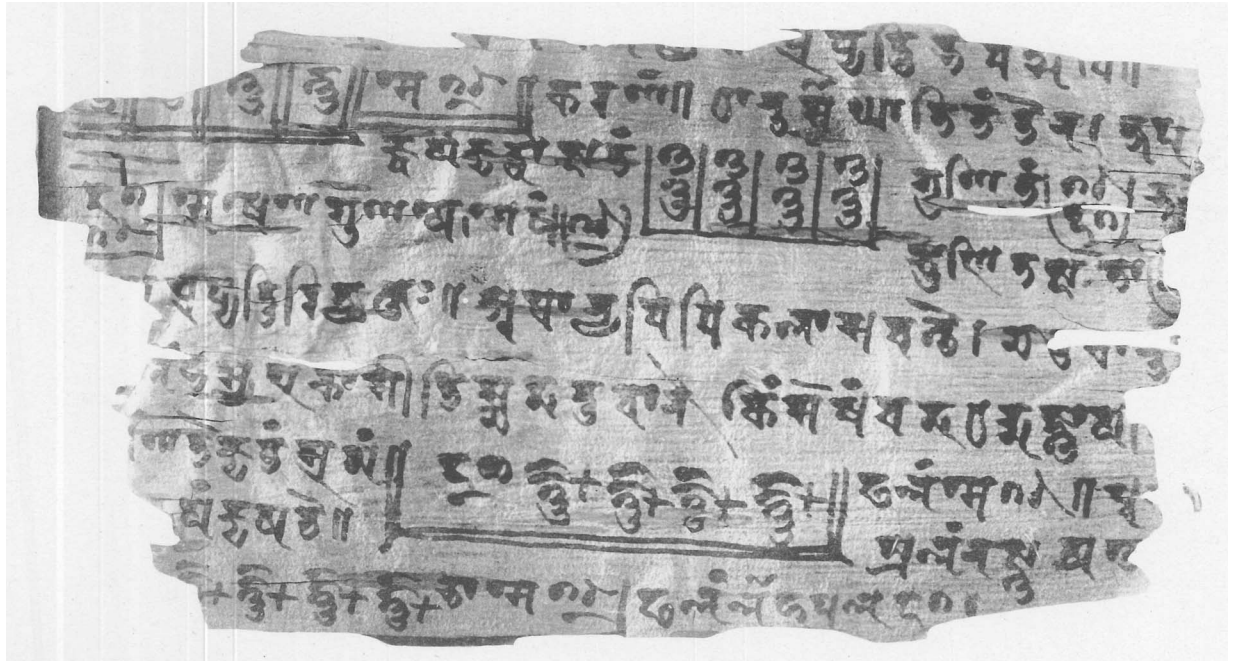


Figure 3: Use of the BAKHSHALI MINUS SIGN in folio 1r of the manuscript (from Kaye 1927: 22).

. y . . . pravṛittibhavetsakhe || [15v.]
 3 | 3 | 1 | 1 | še 16 | karaṇam || dhāntaśoghātitaṁtena | rūpa
 3 | 3 | 3 | 3 | 1 | kshayaṁkṛitvājātam | 2 | 2 | 2 | 2 | guṇitam | 16 | bha.
 81 | śeshenagūṇaye | śesham | 16 | 3 | 3 | 3 | 3 | guṇitajātā | 8 .
 . . . pravṛittirityarthah || athānyavidhikalāsavarṇe | chaturdhānta
 . . . lohasya ekāśṭīśhadattavān kimśeshamvadadharmajñaya .
 . . . nitekṛitamśramam | 81 | 1 | 1 | 1 | 1 | phalaṁśe 16 || pu .
 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3+ | 3+ | 3+ | 3 | mūlanajñāyate
 1+ | 1+ | 1+ | 1+ | bhāśe 16 | phalaṁlohapala 81 ||
 3 | 3 | 3 | 3 | 1

Figure 4: Use of the BAKHSHALI MINUS SIGN in a transliteration of folio 1r (from Kaye 1927: 105).

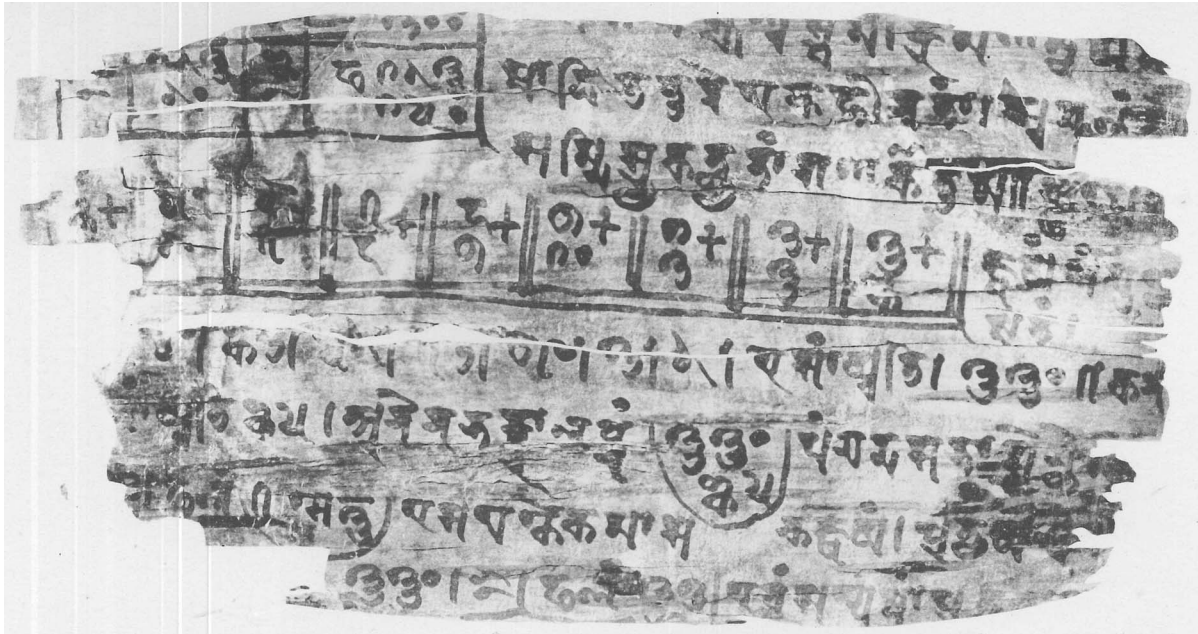


Figure 5: Use of BAKHSHALI MINUS SIGN in folio 17v of the manuscript (from Kaye 1927: 22).

.	.	.	200	srūṇuśvame		kramenadvayam	[17v.]												
0	163	4	pha 163	shādi uttare ekahīnatām		suvarṇamīme	.												
1	60	1	150	sammiśryakatthyatāṅgaṇakottama		sthāpanam													
4+	5+	6+	7+	8+	9+	1+	2+	3+	kshayaṁsaṅguṇya										
.	6	7	8	9	10	2	3	4	jātam										
.	30		42		56		72		90		2		6		eśāmyuti		330		kana
.	myuti	45		anenabhaktvā labdham	330		pañchadaśabhāgechcheda												
.		phalaṁ	7	śe	1		eka	ekaikamāśa	45		kakshayam		pratyaya	.					
.	330		1		phalaṁ	22		evaṁsarveshāṁprat	.						
.		1							

Figure 6: Use of BAKHSHALI MINUS SIGN in a transliteration of folio 17v (from Kaye 1927: 105).

Negative sign.

61. The only distinct mathematical symbol employed is the sign for a negative quantity, which takes the form of a cross + placed after the number affected. This is peculiar and has given rise to discussion. In Sanskrit manuscripts a dot before the quantity affected is the usual method of indicating a negative quantity. In the transliteration of the text the original negative sign (+) is, perhaps illogically, preserved; but it is a rather special feature of the manuscript, easily printed, and leading to no ambiguity.

On this negative sign Dr. Hoernle writes¹ :

“Here, therefore, there appears to be a mark of great antiquity. As to its origin I am unable to suggest any satisfactory explanation. I have been informed by Dr. Thibaut of Benares that Diophantos in his Greek arithmetic uses the letter ψ (short for $\epsilon\lambda\lambda\epsilon\iota\psi\iota\varsigma$) reversed (thus \uparrow) to indicate the negative quantity. There is undoubtedly a slight resemblance between the two signs; but considering that the Hindus did not get their elements of the arithmetical science from the Greeks,² a native Indian origin of the negative sign seems more probable. It is not uncommon in Indian arithmetic to indicate a particular factum by the initial syllable of a word of that import subjoined to the terms which compose it The only plausible suggestion I can make is, that it is the abbreviation (*ka*) of the word *kanita*, diminished.” (He also points out that the letter *k* in its ancient shape as used in the Asoka inscriptions is a cross and goes on to say) “Another suggestion is, that the sign represents the syllable *nū*, an abbreviation of *nyūna*, ‘diminished.’ The *akshara* for *nū* (or *nu*) in the Asoka characters would very closely resemble a cross (+) However for the present, the question must be left an open one.”

With this last remark I agree and I would at the same time point out the danger of attempting to trace an isolated symbolic form back through the ages. The suggested connexion with Aśoka times is only part of the special pleading for the extreme antiquity of our manuscript. The striking resemblance with the Diophantine symbol, so lightly discarded by Dr. Hoernle, is of interest, but lacks support. From the time of Diophantus to the time of the Bakhshālī manuscript is too great³ to allow us to ignore the lack of other examples.

Figure 7: Description of the BAKHSHALI MINUS SIGN (from Kaye 1927: 22).

Symbols and notation.

127. Not unconnected with the scriptural questions are the forms of symbols, and particularly those connected with the arithmetical notation.

The negative symbol, or minus sign, is a cross +, the use of which for this particular purpose is unique. The nearest approach to this use is the inverted ψ (ϕ) employed by Diophantus to indicate a negative quantity. Dr. Hoernle rejected the Diophantine origin of the Bakhshālī symbol on the ground that “the Hindus did not get their elements of the arithmetical science from the Greeks.”¹ That such a sweeping assumption as this is altogether unjustifiable has been already shown, and the implication that the work is wholly Hindu in origin has never been proved. Dr. Hoernle attempts to trace the sign back to the Aśoka *ka* but, as he confesses, not with much success. However he suggests that the Bakhshālī symbol is “a mark of great antiquity.” See § 61 for some further discussion. All that we can now say is that the use of this symbol cannot be traced to an Indian source.

The arithmetical notation employed will be referred to again (see § 130). Here we are concerned with the forms of the symbols only. In my paper published by the Asiatic Society of Bengal in 1912, I attempted to place these symbols epigraphically. Unfortunately we have very few examples of numerical symbols written in early Śāradā, but on the whole the Bakhshālī symbols resemble most closely those of the Devī-rī-koṭhī Fountain inscription² of A. D. 1159. The Śāradā numerical symbols are fairly consistent in form but there are rather peculiar variations of the “four” and “six.” The Bakhshālī “four” most closely resembles the example in No. 15 Chambā which probably belongs to the eleventh century.³ The evidence is really too scanty for us to form any definite conclusion.

Figure 8: Another description of the BAKHSHALI MINUS SIGN (from Kaye 1927: 78).

**ISO/IEC JTC 1/SC 2/WG 2
PROPOSAL SUMMARY FORM TO ACCOMPANY SUBMISSIONS
FOR ADDITIONS TO THE REPERTOIRE OF ISO/IEC 10646¹**

Please fill all the sections A, B and C below.

Please read Principles and Procedures Document (P & P) from <http://www.dkuug.dk/JTC1/SC2/WG2/docs/principles.html> for guidelines and details before filling this form.

Please ensure you are using the latest Form from <http://www.dkuug.dk/JTC1/SC2/WG2/docs/summaryform.html>.

See also <http://www.dkuug.dk/JTC1/SC2/WG2/docs/roadmaps.html> for latest Roadmaps.

A. Administrative

1. Title:	Proposal to Encode the BHAKSHALI MINUS SIGN for Sharada
2. Requester's name:	<i>Script Encoding Initiative (SEI) / Anshuman Pandey (pandey@umich.edu)</i>
3. Requester type (Member body/Liaison/Individual contribution):	<i>Liaison contribution</i>
4. Submission date:	<i>2013-04-25</i>
5. Requester's reference (if applicable):	
6. Choose one of the following:	
This is a complete proposal:	<input checked="" type="checkbox"/> Yes
(or) More information will be provided later:	<input type="checkbox"/>

B. Technical – General

1. Choose one of the following:	
a. This proposal is for a new script (set of characters):	
Proposed name of script:	
b. The proposal is for addition of character(s) to an existing block:	
Name of the existing block:	<i>Sharada</i>
2. Number of characters in proposal:	<i>1</i>
3. Proposed category (select one from below - see section 2.2 of P&P document):	
A-Contemporary <input checked="" type="checkbox"/> B.1-Specialized (small collection) <input type="checkbox"/> B.2-Specialized (large collection) <input type="checkbox"/>	
C-Major extinct <input type="checkbox"/> D-Attested extinct <input type="checkbox"/> E-Minor extinct <input type="checkbox"/>	
F-Archaic Hieroglyphic or Ideographic <input type="checkbox"/> G-Obscure or questionable usage symbols <input type="checkbox"/>	
4. Is a repertoire including character names provided?	<input checked="" type="checkbox"/> Yes
a. If YES, are the names in accordance with the "character naming guidelines" in Annex L of P&P document?	<input checked="" type="checkbox"/> Yes
b. Are the character shapes attached in a legible form suitable for review?	<input checked="" type="checkbox"/> Yes
5. Fonts related:	
a. Who will provide the appropriate computerized font to the Project Editor of 10646 for publishing the standard?	<i>Anshuman Pandey</i>
b. Identify the party granting a license for use of the font by the editors (include address, e-mail, ftp-site, etc.):	<i>Anshuman Pandey (pandey@umich.edu)</i>
6. References:	
a. Are references (to other character sets, dictionaries, descriptive texts etc.) provided?	<input checked="" type="checkbox"/> Yes
b. Are published examples of use (such as samples from newspapers, magazines, or other sources) of proposed characters attached?	<input checked="" type="checkbox"/> Yes
7. Special encoding issues:	
Does the proposal address other aspects of character data processing (if applicable) such as input, presentation, sorting, searching, indexing, transliteration etc. (if yes please enclose information)?	<input checked="" type="checkbox"/> Yes

8. Additional Information:

Submitters are invited to provide any additional information about Properties of the proposed Character(s) or Script that will assist in correct understanding of and correct linguistic processing of the proposed character(s) or script. Examples of such properties are: Casing information, Numeric information, Currency information, Display behaviour information such as line breaks, widths etc., Combining behaviour, Spacing behaviour, Directional behaviour, Default Collation behaviour, relevance in Mark Up contexts, Compatibility equivalence and other Unicode normalization related information. See the Unicode standard at <http://www.unicode.org> for such information on other scripts. Also see Unicode Character Database (<http://www.unicode.org/reports/tr44/>) and associated Unicode Technical Reports for information needed for consideration by the Unicode Technical Committee for inclusion in the Unicode Standard.

¹ Form number: N3902-F (Original 1994-10-14; Revised 1995-01, 1995-04, 1996-04, 1996-08, 1999-03, 2001-05, 2001-09, 2003-11, 2005-01, 2005-09, 2005-10, 2007-03, 2008-05, 2009-11, 2011-03)

C. Technical - Justification

1. Has this proposal for addition of character(s) been submitted before? If YES explain	No
2. Has contact been made to members of the user community (for example: National Body, user groups of the script or characters, other experts, etc.)? If YES, with whom? If YES, available relevant documents:	No
3. Information on the user community for the proposed characters (for example: size, demographics, information technology use, or publishing use) is included? Reference:	Yes <i>Size of user community is unknown.</i>
4. The context of use for the proposed characters (type of use; common or rare) Reference:	Common <i>Character used in historical Sharada manuscripts</i>
5. Are the proposed characters in current use by the user community? If YES, where? Reference:	Yes <i>Character is historical, but is attested in manuscripts and printed works, which are used by modern scholars</i>
6. After giving due considerations to the principles in the P&P document must the proposed characters be entirely in the BMP? If YES, is a rationale provided? If YES, reference:	N/A
7. Should the proposed characters be kept together in a contiguous range (rather than being scattered)?	N/A
8. Can any of the proposed characters be considered a presentation form of an existing character or character sequence? If YES, is a rationale for its inclusion provided? If YES, reference:	No
9. Can any of the proposed characters be encoded using a composed character sequence of either existing characters or other proposed characters? If YES, is a rationale for its inclusion provided? If YES, reference:	No
10. Can any of the proposed character(s) be considered to be similar (in appearance or function) to an existing character? If YES, is a rationale for its inclusion provided? If YES, reference:	No
11. Does the proposal include use of combining characters and/or use of composite sequences? If YES, is a rationale for such use provided? If YES, reference: Is a list of composite sequences and their corresponding glyph images (graphic symbols) provided? If YES, reference:	No
12. Does the proposal contain characters with any special properties such as control function or similar semantics? If YES, describe in detail (include attachment if necessary)	No
13. Does the proposal contain any Ideographic compatibility characters? If YES, are the equivalent corresponding unified ideographic characters identified? If YES, reference:	No