Language Manual

Norwegian

Trygve and Vegard

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1 General

This document discusses certain aspects of text-to-speech processing for the Norwegian text-to-speech system, in particular the different types of input characters and text that are allowed.

This version of the document corresponds to the High Density voices Trygve and Vegard.

1.1 Notational conventions

The following notational conventions are used in this manual:

- For linguistic entities in general, **boldface** is used.
- Input text is written in a `non proportional font`.
- Output text is written in *italics*.
- Keyboard entities are written within angle brackets < >.
- Phonetic transcriptions are written within slashes or hash marks depending on the phonetic alphabet used.

The following abbreviations are used in this manual:

LM	Letter mode
SM	Sentence mode

See the User's Guide for a description of the two different reading modes. Note that Sentence mode sometimes is referred to as Normal mode.

2 Letters in orthographic text

The characters **A-Å** and **a-a** may constitute a word. The apostrophe character <**'**> and quotes <**"**> are also considered as letters.

Vowels with the diacritics < ` ´ ^ >, for example **é**, are accepted but the accent marks are coded internally in the system as slash < **/** > for acute accent (< ´ >) and quotes < " > for grave (< ` >) and circumflex (< ^ >) accent. Thus, in letter mode, **é** is read as *skråstreck e* in LM. An apostrophe can be used instead of the acute accent mark with the same effect, see section 6.4.1.

Note that "German y", **u**, is normally read as *å* with the exception for some names, for example **Muller**. "Spanish n", **n**, is read as *ny*.

Characters outside of these ranges, i.e. digits and non-alphanumeric characters such as punctuation characters and currency markers etc, are not considered as letters. If such a non-letter is included within a word, the word is ended where the non-letter appears and the following letters considered belonging to a new word.

3 Non-alphanumeric characters

The processing of non-alphanumeric characters varies, depending on the reading mode, context of the character, and its function within that context. There are three types of non-alphanumeric characters to be distinguished:

- Characters always processed as punctuation, and having a direct effect on the intonation and pausing in SM.
- Other non-alphanumeric, non-punctuation characters that are always pronounced, with no effect on the intonation or pausing.
- Characters whose pronunciation varies according to context.

Below is a discussion of the characters grouped by type. For each character, the pronunciation is given in the three basic reading modes.

3.1 Punctuation characters

Table 1 lists punctuation characters permitted in the normal text input string and their readings in LM. In SM they are silent but they affect both rhythm and intonation as described in the sections below.

Character	LM
,	*komma*
:	*kolon*
;	*semikolon*
"	*anførselstegn*
'	*apostrof*
.	*punktum*
?	*spørsmålstegn*
!	*utroptegn*
(	*venstreparentes*
)	*høyreparentes*

Table 1 Punctuation characters

3.1.1 Comma, colon and semicolon

Comma < **,** >, colon < **:** > and semicolon < **;** > cause a brief pause where they occur in a sentence. Comma is used as decimal marker in numbers, see section 4.4.

3.1.2 Quotation marks

Quotes < **"** > appearing around a single word or a group of words cause a brief pause before and after the quoted text.

3.1.3 Apostrophe

Apostrophe is used in two different ways:

- To separate inflectional endings from words not following the normal spelling conventions. Example: **NRK's** and **cup'en**.
- Instead of accent marks in some words and names with foreign origin. The system also accepts vowels with accent marks, see section 2.
  Example: **ide'** and **Karle'n**.

3.1.4 Full stop

A full stop < **.** > is a sentence terminal punctuation mark which causes a neutral sentence intonation and a somewhat longer pause. A full stop may also be used as a decimal marker in numbers, see section 4.4.

3.1.5 Question mark

A question mark <**?**> ends a sentence and causes a rising intonation followed by a pause.

3.1.6 Exclamation mark

The exclamation mark <**!**> has a similar effect as the full stop, but causes a more noticeable rise in intonation.

In order to improve the intonation, i.e. make it more natural, there are word accent marks that can be used, see section 5.5.1.

3.1.7 Parentheses

Parentheses < **( )** > around a single word or a group of words cause a brief pause before and after the bracketed text. In LM, they are read as *parentes* and *parentes slutt* when surrounding a numeric expression.

3.2 Other non-alphanumeric characters

Each of the characters in Table 2 are pronounced in all modes. Exceptions are **%** and **$** whose readings are context sensitive, see below.

Character	LM/SM
#	*nummetegn* (see also 3.3.5)
/	*skråstrek*
@	*krøllalfa*
<	*mindreenntegn*
>	*størreenntegn*
^	*sirkumfleks*
~	*tilde*
`	*omvendt apostrof*
_	*understreking*

Character	LM	SM	
		Following numbers	Other cases
%	*prosenttegn*	*prosent*	*prosenttegn*
$	*dollartegn*	*dollar*	*dollartegn*

Table 2 Other non-alphanumeric characters

3.3 Characters whose pronunciation varies

The pronunciation of the characters listed below varies according to their context.

Character	LM	SM
-	*strek*	(see 3.3.1 & 3.3.5)
=	*likhetstegn*	(see 3.3.2 & 3.3.5)
+	*plustegn*	*pluss* (see also 3.3.5)
*	*stjerne*	(see 3.3.3 & 3.3.5)
&	*ogtegn*	(see 3.3.4)

Table 3 Characters with varying pronunciation

All examples below show the reading in SM.

3.3.1 Hyphen

The reading of hyphen < - > follows the following principles:

- If a digit immediately follows, it is pronounced *minus*.
- If surrounded by spaces, it is pronounced as a short pause.
- If two hyphens are surrounded by digits (with or without spaces around the hyphens), the hyphens are read as *till* in sentence mode.
- When used to mark compound words, it is not pronounced. The compound is read as one word.
- Hyphen is discarded at the end of a line, and causes the two parts of the hyphenated word to be joined into a single word.
- A single hyphen is not read if immediately preceded by a letter, but two or more hyphens are read as *streck*.
- In most other cases, hyphen is pronounced *strek*.

Expression	Reading
-3	*minus 3*
234 - 34	*tohundreogtrettifire* (pause) *trettifire*
Han var mørk - det er jeg sikker på	*han var mørk* (pause) *det er jeg sikker på*
1940—45	*nittenhundreogførti til førtifem*
data-maskin	*datamaskin*
Det er mange diri- genter her	*Det er mange dirigenter her.*
-cd-	*strek C D*
--cd--	*to streker C D to streker*

3.3.2 Equals sign

Equals sign < = > is pronounced *er lik* in SM, *likhetstegn* in all other cases.

Expression	Reading
2*3=6	*to ganger tre er lik seks*
cb==bc	*C B to likhetstegn B C*

3.3.3 Asterisk

Asterisk < ***** > is pronounced *ganger* in SM if a digit immediately precedes and follows it; it is pronounced *stjerne/stjerner* in all other cases.

Expression	Reading
2*3	*to ganger tre*
*bc	*stjerne B C*

3.3.4 &-sign

The character < & > ir read *og* when appearing once in SM, in other cases it is read *ogtegn*.

3.3.5 Multiple occurrences of the same character

If more than one of the characters < **( ) = + - *** #> occur in sequence without a space separating the characters, the system will read the number of occurrences and the name of the character in question. If more than 50, the reading will be *mer enn 50* + the name of the character. Note that this is not valid for the characters < **. ! ?** >.

When it comes to letters, the rules are not as straight forward as above. Generally, the system tries to shorten a sequence of identical letters. If a sequence of identical consonants is preceded and followed by a vowel, the system reads the string as containing only two occurrences of the consonant.

Example: `atttttten` is read as `atten`.

Words beginning with a combination of consonants not possible in Norwegian are read letter by letter (until an apostrophe appears). Example: `BRBTIS` is read *B R B T I S*, `BRBTI'S` is read *B R B T Is*.

3.4 Characters ignored by the system

All characters that are not described in section 2 and 3 and that are not phonetic symbols or digits, are ignored by the system. Normally, these characters are omitted but some of them may cause the sentence they appear in to be silent. Some control characters are read in LM.

4 Number processing

Strings of digits that are sent to the text-to-speech converter are processed in several different ways, depending on the reading mode, format of the digit string, and the immediately surrounding punctuation or non-numeric characters. To familiarise the user with the various types of formatted and non-formatted strings of digits that are recognised by the system, we provide below a brief description of the basic number processing along with examples.

Number processing is subdivided into the following categories:

- 4.1 Full number pronunciation
- 4.2 Year reading
- 4.3 Leading zero
- 4.4 Decimal numbers
- 4.5 Currency amounts, Time of day and Dates
- 4.6 Arithmetic operators
- 4.7 Mixed digits and letters

The examples in this section show the reading in SM. In LM, all digits are read as separate digits and all punctuation marks are read.

Note that there is no provision for reading ordinal numbers, currency amounts, time expressions or date formats in the current Norwegian system.

4.1 Full number pronunciation

Full number pronunciation is given for the whole number part of the digit string, i.e. the part to the left of the decimal marker (comma or full stop).

Numbers denoting thousands, millions and billions (numbers larger than 999) may be grouped in groups of three digits starting from the end of the number or from a decimal marker. Space (not full stop) is used as separator. Numbers that do not follow this pattern are read group by group. The highest number read is 99999999999999999 (seventeen digits). Numbers higher than this may be read incorrectly.

Number	**Reading**
`2425`	*totusenfirehundreogtjuefem*
`1000000005`	*en miljard og fem*
`2.425 .&`	*to punkt firehundreogtjuefem* (pause) *og*
`14. oktober`	*fjorten* (pause) *oktober*

4.2 Year reading

A four digit number between 1100 and 1999 is read as hundreds (year reading).

Expression	**Reading**
`1088`	*ettusenogåttiåtte*
`1900`	*nittonhundre*
`1988`	*nittonhundreogåttiåtte*
`1988,0`	*nittonhundreogåttiåtte komma null*
`1988.0`	*nittonhundreogåttiåtte punkt null*

4.3 Leading zero

Numbers that begin with 0 (zero) are read digit by digit if the number contains more than three digits in total. Shorter numbers beginning with zero are read as one or two zeros followed by a full number.

Number	**Reading**
09253	*null ni to fem tre*
013	*null tretten*
003	*null null tre*

4.4 Decimal numbers

Full stop or comma are recognised as decimal markers in the Norwegian system. The full number part to the left of the decimal marker is read according to the number processing rules above. If the decimal part contains more than two digits, this part will be read as separate digits.

Number	**Reading**
0.425	*null punkt firehundreogtjuefem*
3,14	*tre komma fjorten*
3,1415	*tre komma en fire en fem*

4.5 Currency amounts, Time of day, and Dates

There are no special rules for reading currency amounts, time expressions or date formats in the current Norwegian system.

4.6 Arithmetic operators

Numbers together with arithmetical operators are read according to the examples below. See also section 3.2.

Expression	**Reading**
-12	*minus tolv*
+24	*pluss tjuefire*
2*3	*to ganger tre*
25%	*tjuefem prosent*
3,4%	*tre komma fire prosent*
,05%	*komma null fem prosent*
10.30-15	*ti punkt tretti minus femten*

4.7 Mixed digits and letters

If a letter appears within a sequence of digits, the groups of digits will be read as numbers according to the rules above. The letter marks the boundary between the numbers. The letter will also be read. If there is a sequence of letters within a digit string, the sequence will be read according to the normal pronunciation rules.

Expression	**Reading**
77B84Z3	*syttisju B åttifire Z tre*
77BO84Z3	*syttisju bo åttifire Z tre*
77BDG84Z3	*syttisju B D G åttifire Z tre*
0092B87-B	*null null ni to B åttisju strek B*
208Kr	*tohundreogåtte kroner*

5 Norwegian Phonetic Text

In the current version of the text-to-speech system, SAMPA (Speech Assessment Methods Phonetic Alphabet) is used when making lexicons or using phonetic strings within texts. In earlier versions, RULSYS was used. For the voices based on RULSYS, a conversion is made automatically from SAMPA to RULSYS inside the system.

We recommend new users to use only SAMPA since this is the notation that will be used in future development. Users who are already familiar with the RULSYS alphabet still have the possibility to use it when making user lexicons for all RULSYS-based voices (among them the Norwegian voices Trygve and Vegard). There will be a description of RULSYS in the next section.

For the sake of clarity, SAMPA transcriptions are written within slashes (/ /) and RULSYS transcriptions within hash marks (# #). Note that neither the slashes nor the hash marks are part of the actual transcription.

The Norwegian system uses a phonetic alphabet similar to the Norwegian subset of SAMPA. The phonetic alphabet is described below. The system is based on standard Oslo pronunciation

If the pronunciation is incorrect the user may write phonetic transcriptions in the text. Then, a PRN-tag is needed to switch to phonetic mode, see User's Guide. It is also possible to make user lexicons (see User's Guide), or change the orthography of a word (see section 7) in order to achieve the preferred pronunciation.

5.1 Consonants

Table 4 lists the phonetic symbols used for the Norwegian consonants along with example words (the letters corresponding to the consonant sound are in boldface) and their transcriptions.

Consonant-symbol	Example	Transcription
b	**b**e	/b e:4/
d	ba**d**e	/b A:3 d @/
rd	ve**rd**i	/v { rd i:4/
f	**f**ar	/f A:4 r/
g	**g**å	/g O:4/
h	**h**a	/h A:4/
j	**j**a	/j A:4/
k	**k**an	/k A4 n/
C	**kj**ole, **tj**ern	/C u:3 l @/, /C {:4 rn/
l	ha**l**e	/h A:3 l @/
rL	blå, fæ**l**	/b rL O:4/, /f {:4 rL/
rl	Ja**rl**e	/j A:3 rl @/
m	**m**or	/m u:4 r/
n	**n**ord	/n u:4 r/
rn	je**rn**	/j {:4 rn/
N	sa**ng**, sy**ng**e	/s A4 N/, /s y3 N @/
p	**p**ris	/p r i:4 s/
r	**r**a**r**	/r A:4 r/
s	**s**a	/s A:4/
rs	ve**rs**, ve**rsj**on	/v {4 rs/, /v { rs u:4 n/
S	sta**sj**on, ve**rsj**on	/s t A S u:4 n/, /v { S u:4 n/
t	**t**a	/t A:4/
rt	ve**rt**	/v {4 rt/
v	**v**i	/v i:4/
?	ja-a	/j A:3 ? A/

Table 4 Norwegian consonant symbols in SAMPA

Note that /**rs**/ and /**S**/are equivalent.

5.2 Comments on phonetic symbols for consonants

5.2.1 Glottal stop

A glottal stop, represented by the phonetic symbol /**?**/, is a small sound which is used in Norwegian to separate two words when first ends in a vowel and the second word starts with a stressed vowel. This sound can be inserted in order to improve the pronunciation.

5.2.2 Retroflex sounds

The pronunciation of the dental consonants **T**, **D**, **S**, **L** and **N** is changed when preceded by **R**. The resulting sounds are called 'supradentals' or 'retroflex'. This pronunciation of **T**, **D**, **S**, **L**, and **N** is represented by the merging of /**r**/ and the following consonant symbol, i.e /**r t**/ becomes /**rt**/. Note that **R** also may affect more than one of the following consonants.

Examples	**svart**	`/s v A4 rt/`
	gardin	`/g A rd i:4 n/`
	kors	`/k O4 rs/`
	Karl	`/k A:4 rl/`
	barn	`/b A:4 rn/`
	verst	`/v {4 rs rt/`
	jeg har sett	`/j {i4 h A:4 rs e4 t/`

5.3 Vowels

Table 5 lists the phonetic symbols used for the Norwegian vowels along with example words and their transcriptions.

Vowel symbol	Example	Transcription
A:	m**a**t	/m A:4 t/
A	m**a**tt	/m A4 t/
e:	v**e**t	/v e:4 t/
e	v**e**tt	/v e4 t/
@	mat**e**	/m A:3 t @/
i:	f**i**le	/f i:3 l @/
i	f**i**lle	/f i3 l @/
u:	b**o**ne	/b u:3 n e/
u	b**o**nde	/b u3 n @/
}:	l**u**t	/l }:4 t/
}	l**u**tt	/l }4 t/
y:	l**y**ne	/l y:3 n @/
y	l**y**nne	/l y3 n @/
{:	h**e**r	/h {:4 r/
{	h**e**rr	/h {4 r/
2:	m**ø**t	/m 2:4 t/
2	m**ø**tt	/m 24 t/
O:	v**å**t	/v O:4 t/
O	v**å**tt	/v O4 t/
{i	l**ei**	/l {i4/
Ai	h**ai**	/h Ai4/
ui	k**oi**e	/k ui3 @/
2y	k**øy**e	/k 2y3 @/
{}	h**au**g	/h {}4/ or /h {}4 g/

Table 5 Norwegian vowel symbols in SAMPA

5.4 Comments on phonetic symbols for vowels

5.4.1 Unstressed /**e**/

In Oslo pronunciation, short unstressed /**e**/ is in many cases reduced and is then denoted/**@**/ in SAMPA. This sound is very common in endings such as **-E**, -**ER**, -**ET**, -**EN**, -**ENE**, -**ENS** etc. The system automatically converts /**e**/ to /**@**/ in these cases.

5.5 Extra symbols for phonetic details

In the current version of the Norwegian synthesis certain phonetic details can be specified in phonetic text. This can be exploited in case the user wishes to achieve an unusual pronunciation, or if the transcription automatically generated by the system is inaccurate.

5.5.1 Lexical stress

In words with more than one syllable, one (and normally only one) of the syllables is more prominent than the others. This is referred to as word stress, or lexical stress. Words of one syllable also have word stress when spoken in isolation, although many may lose the stress in certain contexts.

In Norwegian, lexical stress is often used to distinguish between two words that are spelled alike, but pronounced differently. It is therefore very important to include stress marks when writing transcriptions.

Note that the accent marks discussed below are used in transcriptions and that they are not the same as the orthographic accent marks (diacritics) discussed in section 2.

There are two word accents in Norwegian: acute and grave. The acute accent is in SAMPA denoted by a < **4** > placed immediately after the stressed vowel, the grave by a < **3** > placed similarly. Secondary stress, most often appearing in the last part of a compound (see below), is denoted by a < **1** >.

Example **plasser** can be pronounced in the following two ways:

`/p l A s e:4 r/`	(imperative of **a plassere,** acute accent).
`/p l A3 s @ r/`	(plural of **plass,** grave accent)

Monosyllabic words and words with stress on the last syllable always have the acute accent.

Example	`/v e:4 t/`	(**vet**)
	`/b A n A:4 n/`	(**banan**)

For compound words, i.e. words composed of two or more separate words, but written as one word, sometimes using a hyphen ("-"), the rules are more complicated.

The main stress is normally on the first part. An acute accent on the first part (marked with <**4**> after the vowel) is often changed to a grave accent (marked with <**3**>), especially if the first part consists of just one syllable.

The last part will normally have one syllable carrying 'secondary stress'. Normally this will be the same syllable that would have the main stress if this was used as a word in its own right. If the last part consists of more than one syllable, the syllable with secondary stress usually stands out more than the others. The secondary stress can be marked with <**1**> after the vowel. It can make an important difference to the pronunciation to mark the secondary stress, but often it does not make much difference.

Apart from affecting the intonation, the presence of a secondary stress causes aspiration (see 5.5.2) of a preceding **/p/**, **/t/**, **/k/** or **/rt/** (unless an **S** sound precedes this). Examples:

hus	`/h }:4 s/`	**vognene**	`/v O3 N n @ n @/`	**husvognene**	`/h }:3 v O1 N n @ n @/`
vogn	`/v O4 N n/`	**toget**	`/t O:4 g @/`	**vogntoget**	`/v O3 N n t O:1 g @/`
grønn	`/g r 24 n/`	**saker**	`/s A:3 k @ r/`	**grønnsaker**	`/g r 23 n s A:1 k @ r/`
grønn	`/g r 24 n/`	**kal**	`/k O:4 l/`	**grønnkal**	`/g r 24 n k O:1 l/`

5.5.2 Emphasis and reduction

It is also possible to emphasise or reduce the stress on a particular word. In the input text string, this is done by placing < **_X** >, where **X** represents a single digit between **0** and **9**, within a PRN-tag (see Users Guide) immediately before the word whose prominence is to be altered. The emphasis mark can also be used in transcriptions in a user lexicon.

_2	normal stress for most words
_0	makes a word non-stressed
_1	gives stress to a normally unstressed word
_3 - **_9**	gives levels of emphatic stress

5.5.3 Punctuation marks

The punctuation marks < **. ! ? ,** > used in phonetic text have the same effect on intonation as when appearing in orthographic text. In SAMPA the punctuation marks are denoted /**_.**/, /**_!**/, /_?/, and /**_com**/ respectively.

5.5.4 Aspiration

In Oslo pronunciation, the voiceless stop sounds **P**, **T**, **K** are typically *aspirated* in certain positions of the word. That is, they are followed by a "puff of breath" before vowels. This happens when the stop sound is followed by a stressed vowel, unless an **S** sound precedes in the same syllable. Aspirated sounds are also found word initial in a separate word or within a compound.

The synthesis cannot always correctly predict when a voiceless stop is to be aspirated. The user can indicate the aspiration of a voiceless stop by placing /**_h**/ after the stop symbol.

Example **Frognerparken** /f r O3 g n e r p_h A1 r k @ n/

5.5.5 Foreign sounds

A few non-Norwegian sounds, which sometimes occur in the pronunciation of foreign words and names, are permitted in the transcriptions of the current version of the Norwegian synthesis. Depending on which voice is chosen, these sounds will be rendered more or less similar to the foreign speech sounds. The sounds in question are exemplified in Table 6.

Phonetic symbol	Example	Transcription	Language of origin
T	**Th**atcher	/T e4 tS @ r/	English
D	**th**is	/D i4 s/	English
x	Ba**ch**	/b A4 x/	German
	Lo**ch**	/l O4 x/	Scottish English
w	**W**indo**w**s	/w i4 n d u: z/	English
z	Windo**w**s	/w i4 n d u: z/	English
tS	**Ch**urc**h**ill	/tS 2:4 tS i l/	English
dZ	**J**ohn	/dZ O4 n/	English
Z	**Z**oo**z**	/Z u:4 Z/	English

Table 6 Phonetic symbols for foreign sounds

6 The RULSYS phonetic alphabet

Note that we recommend new users to use only SAMPA since this is the notation that will be used in future development. Note also that it is only possible to use RULSYS when making user lexicons, not in the input text string.

The following differentiates RULSYS from SAMPA in the Norwegian system:

- no spaces are used within words in transcriptions
- the lexical accent is placed before the vowel to be stressed, not after as in SAMPA
- there are symbols for blocking and unstressed /E/

Note that the hash marks (# #) are used to indicate RULSYS transcriptions and to differentiate them from SAMPA transcriptions; the hash marks are not part of the actual transcriptions.

If the pronunciation is incorrect the user may write phonetic transcriptions in the text. Then, a PRN-tag is needed to switch to phonetic mode, see User's Guide. It is also possible to make user lexicons (see User's Guide), or change the orthography of a word (see section 7) in order to achieve the preferred pronunciation.

6.1 RULSYS Consonants

Table 7 lists the phonetic symbols in RULSYS used for the Norwegian consonants along with example words and their transcriptions.

Consonant symbol	Example	Transcription
B	**b**e	#B'E:#
D	ba**d**e	#B"A:DE0#
2D	ve**rd**i	#VÆ2D'I:#
F	**f**ar	#F'A:R#
G	**g**å	#G'Å:#
H	**h**a	#H'A:#
J	**j**a	#J'A:#
K	**k**an	#K'AN#
KJ	**kj**ole, **tj**ern	#KJ"O:LE0#, #KJ'Æ:2N#
L	ha**l**e	#H"A:LE0#
2L	Ja**rl**e	#J"A:2LE0#
M	**m**or	#M'O:R#
N	**n**ord	#N'O:R#
2N	je**rn**	#J'Æ:2N#
NG	sa**ng**, sy**ng**e	#S'ANG#, #S"YNGE0#
P	**p**ris	#PR'I:S#
R	**r**a**r**	#R'A:R#
S	**s**a	#S'A:#
2S	ve**rs**, ve**rsj**on	#V'Æ2S#, #VÆ2S'O:N#
SJ	sta**sj**on, ve**rsj**on	#STASJ'O:N#, #VÆSJ'O:N#
T	**t**a	#T'A:#
2T	ve**rt**	#V'Æ2T#
V	**v**i	#V'I:#
Q	ja-a	#J"A:QA#

Table 7 RULSYS consonants

6.2 Comments on phonetic symbols for consonants

6.2.1 Glottal stop

For a description of glottal stop, see section 5.2.1. Glottal stop is denoted #Q# in RULSYS.

6.2.2 Retroflex sounds

For a description of retroflex sounds, see 5.2.2. In RULSYS, aspiration is denoted by < **2** > plus the consonant in question. Note that the **R** is left out, see examples below. Note that R also may affect more than one of the following consonants.

Examples	**svart**	#SV'A2T#
	gardin	#GA2D'I:N#
	kors	#K'Å2S#
	Karl	#K'A:2L#
	barn	#B'A:2N#
	verst	#V'Æ2S2T#
	jeg har sett	#J'EI+ H'A:+ 2S'ET#

6.3 RULSYS Vowels

Table 8 lists the phonetic symbols in RULSYS used for the Norwegian vowels along with example words and their transcriptions.

Vowel symbol	Example	Transcription
A:	m**a**t	#M'A:T#
A	m**a**tt	#M'AT#
E:	v**e**t	#V'E:T#
E	v**e**tt	#V'ET#
E0	mat**e**	#M"A:TE0#
I:	f**i**le	#F"I:LE0#
I	f**i**lle	#F"ILE0#
O:	b**o**ne	#B"O:NE#
O	b**o**nde	#B"ONE0#
U:	l**u**t	#L'U:T#
U	l**u**tt	#L'UT#
Y:	l**y**ne	#L"Y:NE0#
Y	l**y**nne	#L"YNE0#
Æ: or Ä: or [:	h**e**r	#H'Æ:R# or #H'Ä:R# or #H'[:R#
Æ or Ä or [	h**e**rr	#H'ÆR# or #H'ÄR# or #H'[R#
Ø: or Ö: or \:	m**ø**t	#M'Ø:T# or #M'Ö:T# or #M'\:T#
Ø or Ö or \	m**ø**tt	#M'ØT# or #M'ÖT# or #M'\T#
Å: or]:	v**å**t	#V'Å:T# or #V']:T#
Å or]	v**å**tt	#V'ÅT# or #V']T#
EI	l**ei**	#L'EI#
AI	h**ai**	#H'AI#
OI	k**oi**e	#K"OIE0#
ØY or ÖY or \Y	k**øy**e	#K"ØYE0# or #K"ÖYE0# or #K"\YE0#
AU	h**au**g	#H'AU# or #H'AUG#

Table 8 RULSYS vowels

Note that the following phonetic symbols are equivalent:

- #Ø#, #ö# and #\#
- #Æ#, #Ä# and #[#
- #Å# and #]#.

6.4 Comments on phonetic symbols for vowels

6.4.1 Long and short vowels

In order to differentiate between long and short vowels, a colon < **:** > is used to denote long vowels. For **Æ** and **Ø** infront of **R** and the retroflexes, see section 6.4.2.

Example **vet** #V'E:T#
vett #V'ET#

6.4.2 Æ and Ø in front of R-sounds

Æ and **Ø** have alternative phonetic symbols when preceding an **R** or a retroflex sound. These symbols are #**Æ3**# and #**Ø3#** respectively for long vowels and #**Æ4**# and #**Ø4#** respectively for short vowels.

Examples	**være**	`#V"Æ3RE#`	or	`#V"Æ:RE#`
	herre	`#H"Æ4Re#`	or	`#H"ÆRe#`
	før	`#F'Ø3R#`	or	`#F'Ø:R#`
	førr	`#F'Ø4R#`	or	`#F'ØR#`

Note that #O# or #\# may be used instead of #Ø# that #A# and #[# may be used instead of #Æ#.

6.4.3 Unstressed /**E**/

In Oslo pronunciation, short unstressed /E/ is in many cases reduced and is then denoted/**E0**/ in RULSYS. This sound is very common in endings such as **-E**, -**ER**, -**ET**, -**EN**, -**ENE**, -**ENS** etc. The system automatically converts /**E**/ to /**E0**/ in these cases.

It is possible to block the conversion to /E0/ by adding the symbol /x/ after /E/.

Example	**Mehren**	`#M'E:REN#`	is read	`#M'E:RE0N#`
	mer enn	`#M'E:RexN#`	or	
		`#M'E:RENx#`	is read	`#M'E:REN#`

6.5 Extra symbols for phonetic details

In the current version of the Norwegian synthesis certain phonetic details can be specified in phonetic text. This can be exploited in case the user wishes to achieve an unusual pronunciation, or if the transcription automatically generated by the system is inaccurate.

6.5.1 Lexical stress

Lexical stress is described in 5.5.1 In RULSYS, acute accent is denoted by < ' > and grave accent by < " >. Both are placed immediately in front of the vowel with primary stress. Secondary stress is marked by < ` > (reversed apostrophe or the grave accent mark) and is most often used in the last part of compounds.

Examples	**plasser** (pl. of **plass**)	`#PL"ASE0R#`	(grave accent)
	plasser (imp. of a **plassere**)	`#PLAS'E:R#`	(acute accent)

The system automatically chooses the first alternative; if the second is preferred, there is the possibility of using phonetic text or inserting an apostrophe < ' > after **e** or replace **e** by **é**.

Example	**plasse'r**	are both read	`#PLAS'E:R#`
	plassér		

For a description of compounds, see section 5.5.1. Below are some words and compounds and their transcriptions in RULSYS.

hus	`#H'U:S#`	**vognene**	`#V"ÅNGNE0NE0#`	**husvognene**	`#H"U:SV`ÅNGNE0NE0#`
vogn	`#V'ÅNGN#`	**toget**	`#T'ÅGE0#`	**vogntoget**	`#V"ÅNGN-T`Å:GE0#`
grønn	`#GR'ÖN#`	**saker**	`#S"A:KE0R#`	**grønnsaker**	`#GR"ÖNS`A:KE0R#`
grønn	`#GR'ÖN#`	**kal**	`#K'ÅL#`	**grønnkal**	`#GR'ÖN-K`ÅL#`

6.5.2 Emphasis and reduction

In RULSYS, phrase level stress is denoted in the same way as in SAMPA. See section 5.5.2.

6.5.3 Aspiration

Aspiration is described in section 5.5.2. In RULSYS, aspiration is denoted by adding **hh** to the phonetic symbol for the stop to be aspirated or by adding hyphen <-> in front of the stop to be aspirated.

Example **Frognerparken** `#FR"ÅNGNERPhhARKEN#` or
`#FR"ÅNGNER-PARKEN#`

will both be read `#FR"ÅGNERPARKE0N#` and the #P# will be aspirated.

6.5.4 Unstressed words or the +-sign

In general, all words (separated by spaces) in phonetic text should have their accent marked. In cases where an unstressed pronunciation is preferred, a plus sign < **+** > can be placed immediately after the word to be unstressed. Another way is to write the word immediately after the preceding word or immediately before the following word (but with the normal accent left out).

Example	Orthographic text	Phonetic text
	mer enn fem	`#M'E:R 'ENx+ F'EM#`
		`#M'E:RENx F'EM#`
		`#M'E:R ENF'EM#`

For the use of the symbol **x**, see section 6.3.3.

Note that the use of < **+** > has the same effect as the use of **_0**, see section 6.4.3 above.

6.5.5 Punctuation marks

The punctuation marks < **, . ! ?** > used in phonetic text have the same effect on intonation as when appearing in orthographic text.

6.5.6 Hyphen

Hyphen < **-** > is used to avoid the misinterpreting of consonant sounds. Since there are no spaces in RULSYS transcriptions, the sequences #NG#, #SJ#, and # KJ# are ambiguous since these as well as #N#, #G#, #S#, #J# and #K# are phonetic symbols. A hyphen can be used to separate the symbols.

Example **vasshjul** `#V"AS-JU:L`

6.5.7 Foreign sounds

The RULSYS notation for the foreign sounds is given below.

Phonetic symbol	Example	Transcription	Language of origin
th	**Th**atcher	#**th**'Ä4chE0R #	English
dh	**th**is	#**dh**'IS#	English
x	Ba**ch**	#B'A**X**#	German
	Lo**ch**	#L'Å**X**#	Scottish English
w	**W**indows	#**W**'INDO:Z#	English
Z	Windows	#W'INDO:**Z**#	English
ch	**Ch**urch**h**ill	#**ch**'Ö:**ch**IL#	English

Table 9 Symbols for foreign sounds

7 How to change pronunciation errors

Words that are not pronounced correctly by the text-to-speech converter can be entered in the user lexicon (see User's guide). There are two ways to do this: either, the user enters a phonetic transcription of the word (see section 5), or, the user rewrites the word orthographically. Phonetic transcriptions can also be entered directly in the text, using a PRN-tag (see User's guide).

7.1 Change the orthography

7.1.1 Spelling incorrectly

It is possible to intentionally misspell a word by trying to spell a word in a more phonetic manner, i.e., choosing non-ambiguous letter combinations to represent difficult sounds.

Example **Wall Street** can be misspelled **Wal Strit**

7.1.2 Use of hyphen

A hyphen can be used within a word to separate two letters that might otherwise be incorrectly pronounced together.

Example **isjakt** can be written **is-jakt**

7.1.3 Expanding acronyms

Not very many acronyms are handled by the current Norwegian system (see section 8). Therefore, it may be very useful to expand them in the user dictionary. Since acronyms should be expanded to more than one word it may be difficult to enter a proper transcription. It is much easier to enter the words in question orthographically.

Examples **KNBF** Kongelig Norsk Bat Forbund

7.2 Using phonetic text

When unable to correct a pronunciation error by misspelling the word, phonetic text should be used to produce the desired pronunciation. When phonetic text is used, the system bypasses the normal spelling pronunciation rules, and pronounces each phonetic symbol "literally", according to the examples listed in Tables 4 and 5.

7.2.1 Choosing the right phonetic symbols

A helpful way to transcribe in phonetic text is to work with a dictionary. Normally, dictionaries give the pronunciation for each word. They also provide a pronunciation key to show how to pronounce the special symbols used in the pronunciation guide. Similarly, Tables 4 and 5 give the pronunciation key for the special phonetic symbols used in Norwegian for the text-to-speech converter.

Using a dictionary, look up the word you want to transcribe. Next to the word you should find the pronunciation. Working with the dictionary's pronunciation key and Tables 4 and 5, convert the dictionary pronunciation symbols to the appropriate Norwegian symbols for the text-to-speech converter. Symbols that are used in the dictionary to mark syllable or word boundaries should be ignored. Be sure to include the stress assignment information since lexical stress is an important part of a word's pronunciation.

8 Abbreviations

In the current version of the Norwegian text-to-speech system, the following abbreviations are recognised in all contexts (in SM only). These abbreviations are case-sensitive and require no full stop in order to be recognised as abbreviations. If a full stop accompanies the abbreviation, the sentence is terminated after the abbreviation. Some abbreviations are only recognised in SM, see section 8.1.

The user lexicon may be used to redefine any of these abbreviations, or to create your own.

Abbreviation	LM	SM
ca	*C A*	*cirka*
cm	*C M*	*centimeter*
dr	*D R*	*doktor*
dvs	*D V S*	*det vil si*
etc	*E T C*	*etcetera*
hr	*H R*	*herr*
hhv	*H H V*	*henholdsvis*
kg	*K G*	*kilo*
kl	*K L*	*klokka*
kr	*K R*	*kroner*
kvm	*K V M*	*kvadratmeter*
nr	*N R*	*nummer*
osv	*O S V*	*og så videre*
resp	*R E S P*	*respektive*
tel	*T E L*	*telefon*
tlf	*T L F*	*telefon*

Table 10 Recognised abbreviations in the Norwegian system

8.1 Abbreviations only recognised in SM

The following abbreviations are only recognised if sentence mode is enabled:
f eks (**for eksempel**), **bl a** (**blant annet**) and **m m** (**med mere**).