

Design of Amharic Teleprinter (Teletype)

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EDITOR'S NOTE:

Ato Terrefe has applied for a patent with the Ministry of Commerce and Industry for his adaptation of the Amharic alphabet for coded transmission of information as well as for his design of the keyboard layout for the Amharic teleprinter. We learnt after the Journal had gone to the press that the first model Amharic teleprinter has been manufactured and we understand that Ato Terrefe will soon be leaving for Germany to Messrs Siemens & Halske to test the printer.

INTRODUCTION

Fast and reliable means of communication are essential for the growth of the economy of a nation and for the effectiveness of its defence and security forces. The telephone, telegraph and telex services are nowadays fully recognized in the world as essential day to day needs.

The telephone and the telegraph have been in use in this country for quite a long time. The service that has been introduced recently and has been found extremely attractive to the business community is telex. To describe this service briefly I shall say that it is a means of communication by writing. It is similar to the telegraph service in that the information or message is communicated by writing; and it is also similar to the telephone service in that the communication is carried out directly between the sender and receiver. The sender uses a teleprinter, which when connected to another similar machine over an electrical transmission medium enables the receiver to read the message on his teleprinter.

The present method of handling Amharic telegrams and telex in the domestic network of Ethiopia has been noted to be rather unsatisfactory because the teleprinters used to handle the exchange of such messages employ Latin characters. This means that the client receiving a telegram or telex message must know how to read Latin character, in order to understand the Amharic text, even though he may be literate as far as the Amharic language is concerned. Or else, he has to call a person who knows Latin characters and ask him to read his telegram, thereby revealing his message to a third party. Telegrams being mainly used for business communications such a practice is not at all desirable.

Considering the above drawbacks it was felt necessary to study the feasibility of designing teleprinters that employ Amharic characters.

PRINCIPLES OF THE TELEPRINTER

A teleprinter is an electrical machine, that

looks much like the ordinary typewriter, which upon touching a key prints a character on the paper inserted in it and at the same time on a distant machine that is connected to it via an electrical transmission medium.

The transmission of characters from one printer to another is done by using a code consisting of electric signals with two variables, i.e., current and no current. The standard Latin character machine uses 5 bits of these two variables to signify one character. Therefore the possible different combinations using the above type of code amounts to $2^5 = 32$ possibilities.

DESIGN POSSIBILITIES FOR AMHARIC PRINTERS

I. A Combined Amharic and Latin Character 5--Unit Printer

I-a) As telegram and telex users often have the need to communicate with both domestic and international correspondents it would be highly desirable to use the same printer for both types of communications.

Let us see if the Amharic alphabet can be condensed to be fitted on the unused shift of the Latin printer.

As mentioned above the standard Latin character 5 unit printer consists of 32 possibilities in one shift. These are occupied by the 26 characters plus 6 codes for operational control signals such as space, the different shifts, carriage return etc. In addition this same machine uses 26 other codes on a second shift for the figures and other signs like brackets, plus and minus, bell etc.

For the sake of mechanical and operational simplicity it is not advisable to have more than three shifts on a teleprinter. (Note that the typewriter has only two shifts, i.e., capital and small letters).

Hence on this combined teleprinter we can have 26 free codes on the third shift.

At first glance the Amharic Alphabet appears

to be condensable to 22 basic characters which can give most of the remaining other characters and almost all the variations by just adding extra signs. These consist of ሀ, ለ, መ, ረ, ሰ, ቀ, ቦ, ተ, ነ, ኦ, ወ, ከ, ዘ, ዠ, ዪ, ያ, ገ, ጠ, ጪ, ጸ, ፈ, ፐ, (22)

Besides the following signs would be required to form the different variations:-

For the first order	(ግፅዝ)	፳ ፳	e.g.	ፕ, ጸ
» » second	(ካፅብ)	፳ ፳ ፳	e.g.	ቡ, ፋ
» » third	(ግለስ)	፳ ፳ ፳ ፳	e.g.	ሂ, ቢ, ረ
» » fourth	(ራብፅ)	፳ ፳ ፳ ፳ ፳	e.g.	ባ, ታ
» » fifth	(ግምስ)	፳ ፳ ፳ ፳ ፳ ፳	e.g.	ቤ, ሄ
» » sixth	(ሳድስ)	፳ ፳ ፳ ፳ ፳ ፳ ፳	e.g.	ጉ, ቀ
» » seventh	(ሳብፅ)	፳ ፳ ፳ ፳ ፳ ፳ ፳ ፳	e.g.	ሆ, ሎ, ቦ

These amount to 15 signs.

Additionally the following characters must be inserted as they are since they cannot be formed with the above basic characters and signs. They are (ራ, ና, ሀ, ል, ም, ዝ, ር, ብ, ኦ, ከ, ይ, ግ, ጥ, ጭ, 14 characters)

Thus leaving out the ከ, ጥ, ጭ group and all characters of similar or same sound we require 22+15+14=51 codes. As this type of printer has only 26 spare codes this solution is ruled out.

I-b) Another possibility which should briefly be considered in connection with this combined type of printer, is the often suggested method of modifying the Amharic alphabet to consist of consonants and vowels.

As can be seen by glancing at the alphabet the consonants would amount to 27 and the vowels to 6 adding up to a total of 33. Again this possibility is ruled out as it exceeds the available code of 26 by 7 characters, and as the whole principle of modifying the form of the script is not popular and perhaps not even desirable.

Nevertheless this set up of consonant and vowel is not desirable from the telegraph and telex transmission point of view as it would require more characters to transmit the same message as compared to the existing form of writing.

Example :- አማርኛ በኢትዮጵያ በሕግ የታወቀ ዋናው ቁጥጥር ነው።

Transmitted characters: 27
Number of words: 7

አመለረገኘኦ በኢትዮጵያ በሕግ የታወቀ ዋናው ቁጥጥር ነው።

Transmitted characters: 46
Number of words: 7

Note that the number of transmitted characters is almost double which means that the operation and transmission time has increased tremendously although the chargeable number of words remains the same.

II. A Combined Amharic & Latin 3-shift 6-unit Teleprinter

As solution I appeared to have an insufficient number of codes to accommodate both types of alpha-

bets and the figures, one may consider increasing the code from 5-unit to 6-unit.

With such a code on 3-shifts one can have $3 \times 2^6 = 192$ characters. Out of these, 64 combinations will be used for Latin characters, figures and signs. The latter two would be common to both languages. Thus besides the normal operational codes some 110 combinations can be allocated for the Amharic alphabet. Such a number of combinations is indeed quite big as compared to design possibility I above and III below, and thus the 3-shift 6-unit type of teleprinter seems to be the real solution.

However, when one studies the technical and economical aspect of the introduction of 6-unit teleprinters in the Ethiopian telecommunications network the problems become enormous.

As most transmission equipment, such as, the automatic error correcting equipment are designed for the 5-unit telegraph service, the 6-unit transmission equipment would require special design thereby making it prohibitive in cost. And secondly, as the Latin characters would be incorporated on the said 6-unit teleprinter, these machines would have to be used in the international service. But as all international networks operate on the 5-unit code, converters from 5-unit code to 6-unit code and vice versa will be required. Furthermore, automatic telex exchanges which will soon be introduced in this country will have to be of special design thereby making them nonstandard and therefore costly. Finally, only one or two manufacturers produce 6-unit machines and from budgetary quotation obtained from such a company the price per unit is about 70% higher than the 5-unit version.

Thus, from the economical and technical point of view the 3-shift 6-unit code teleprinter is not practical.

III. A Separate 3-shift 5-unit Amharic Teleprinter

With this type of printer one can have $(3 \times 2^5) = 96$ codes on 3 shifts. Out of these the following must appear on all 3 shifts as they are operational codes: space, back space, carriage return, lower shift, middle shift, upper shift, and line feed (thereby occupying $7 \times 3 = 21$ codes).

We are thus left with $96 - 21 = 75$ character spaces to accommodate the formidable Amharic alphabet which consists of some 268 characters. To make matters worse some 20 character spaces have to be allocated of the above 75, for the figures and signs that are normally required in telegram and telex usage. Hence we are left with 55 spaces for the characters. These have been divided into 43 characters and 12 affixes using which practically all of the alphabet can be reproduced. The following are examples of characters that can not be reproduced by the designed keyboard.

Left out character Equivalent to be used

— ከ — —	— — ኮ —
— ኳ — —	— — ኰ —
— ቂ — —	— — ቃ —
— ጉ — —	— — ጊ —
— ጎ — —	— — ጊ —
— ኋ — —	— — ሀ —
— ቆ — —	— — ለ —
— ሂ — —	— — ሐ —
— ሃ — —	— — ሐ —
— ቄ — —	— — ወ —
— ቅ — —	— — ወ —

Although the 3-shifts 5-unit teleprinter exclusively used for the Amharic alphabet has insignificant limitations in the number of characters it can accommodate, it operates on standard codes using standard transmission equipment. It does not need converters as in II above and its price is quite reasonable as it differs from the Latin printer only in minor mechanical details.

As the above solution is by far the best of the available design possibilities both from the technical and economical points of view, let us now proceed to examine the proposed keyboard layout.

KEY BOARD LAYOUT DESIGN: (Drawing HO 224)

The main criteria adopted to choose what character to include and where to place on the keyboard are the following:

- 1) Can the character be formed using others? If not, must be included, e.g. ጥ, ገ.
- 2) If the character can be formed using others how frequently is it required in normal usage? If often, must be included, e.g. ቸ, ቶ.
- 3) Once it is decided which characters to include, their location has to be chosen based on their frequency of occurrence in telegraph messages. Those which are most used are located on the position of the so called "home keys", and the least used further and further out, e.g., ለ, በ.
- 4) In order to make it easy for operators to remember the location of characters the two most used orders, the first and sixth (ገዕዝና ሳድስ), are placed on the middle and upper shifts respectively. Besides, most keys carry the same character in its two different forms as ሀ, ሁ, ለ, etc. The layout shown in drawing HO 224 based on the above guiding principles is expected to be easy for operators to learn, and to have higher efficiency on operation time.

SIZE AND POSITION OF CHARACTERS ON KEYS (Drawing HO 226 not reproduced here)

There are three distinct types of characters in the alphabet, i.e. one legged ኃ, ተ, two legged በ, ለ, and three legged ጠ, ጢ.

This difference in construction must be taken into consideration when one has to decide the exact position of the affixes in relation with the characters. Thus በ, ኃ, and ጠ, all use the same sign ስ to be attached to the first order of each character. As the location of the sign remains the same once fixed on a key, the relative position of the different characters should be such that the affix will fall exactly on the right spot in relation with the character's size and shape.

For instance, if one were to adjust the position of ስ for character በ, then ኃ shall be located in such a position so that its leg shall fall exactly on the same line as the right leg of በ, and similarly ጠ shall have its third right leg aligned to the right leg of በ.

Such considerations therefore affect the shape and size of the characters and hence the pronounced legs of ጸ and the small spacing between the legs of ጠ.

These variations are so made that on regular print they shall not be noticeable except by the expert.

The proposed shapes and positions are given on drawing HO 226.

CONCLUSION

The above design was presented in 1965 to the Imperial Board of Telecommunications which after carefully studying the design from the economical, technical and other points of view graciously accepted the proposal. The Board has already invited teleprinter manufacturers to produce such machines and supply to the Board for its telegram and telex services. Amharic teleprinters are also expected to be useful for defence and security organizations as well as news agencies and others of similar set up where fast and reliable communication is required.

With the introduction of Amharic Teleprinters, it is hoped that the public at large and government offices in particular will be encouraged to subscribe for telex service which will greatly increase their efficiency at little more cost than the postal service. It is also expected that telegrams shall be used even more as a medium of communication for the average person.

Supplements attached:

- 1) Keyboard Layout for 3 shift 5-unit Amharic Teleprinter - Drawing HO 224.
- 2) Characters' Shape and Position for Amharic Teleprinter - Drawing HO 226. (As this drawing is extremely big it has not been possible to reproduce it here).
- 3) Telegraph code for Amharic Teleprinters -STC No. 3-66.
- 4) Frequency of use of Amharic Characters in Amharic Telegrams - STC No. 64/66 and 65/66.

TELEGRAPH CODE FOR AMHARIC TELEPRINTERS (STC No. 3-66)

NUMBER OF SIGNAL	CCITT 5 - UNIT CODE					SHIFTS		
	1	2	3	4	5	UPPER	MIDDLE	LOWER
1	Z	Z	A	A	A	(-)	h	h
2	Z	A	A	Z	Z	?	ረ	ረ
3	A	Z	Z	Z	A	ማ	ዘ	ዘ
4	Z	A	A	Z	A	WRU	ብ	ብ
5	Z	A	A	A	A	3	ጠ	ጠ
6	Z	A	Z	Z	A	ቧ	ቧ	ቧ
7	A	Z	A	Z	Z	ቧ	ቧ	ቧ
8	A	A	Z	A	Z	5	ሀ	ሀ
9	A	Z	Z	A	A	8	ቸ	ቸ
10	Z	Z	A	Z	A	Bell(+)	ረ	ረ
11	Z	Z	Z	Z	A	(ረ	ረ
12	A	Z	A	A	Z	ቧ	ቧ	ቧ
13	A	A	Z	Z	Z	.	ቀ	ቀ
14	A	A	Z	Z	A	=	ተ	ተ
15	A	A	A	Z	Z	9	የ	የ
16	A	Z	Z	A	Z	0	ደ	ደ
17	Z	Z	Z	A	Z	1	ለ	ለ
18	A	Z	A	Z	A	4	ሰ	ሰ
19	Z	A	Z	A	A)	ጠ	ጠ
20	A	A	A	A	Z	5	ነ	ነ
21	Z	Z	Z	A	A	7	ጸ	ጸ
22	A	Z	Z	Z	Z	ቧ	ቧ	ቧ
23	Z	Z	A	A	Z	2	አ	አ
24	Z	A	Z	Z	Z	/	ረ	ረ
25	Z	A	Z	A	Z	6	ገ	ገ
26	Z	A	A	A	Z	BACK SPACE		
27	A	A	A	Z	A	CARRIAGE RETURN		
28	A	Z	A	A	A	LINE FEED		
29	Z	Z	A	Z	Z	UPPER SHIFT		
30	Z	Z	Z	Z	Z	MIDDLE SHIFT		
31	A	A	Z	A	A	SPACE		
32	A	A	A	A	A	LOWER SHIFT		

Z = stop polarity
A = start polarity

FREQUENCY OF CHARACTERS IN AMHARIC TELEGRAMS (STC No. 64/66)

Noting that Ato Asmarom Legesse's table* of frequency of characters was not based on the study of telegrams, I made a study of telegrams and derived the table given on next page.

The statistics were taken from different months of the year and from different towns to and from Addis Ababa. This was done because it is known that messages from certain areas refer mainly to particular products or subjects which may have

economic or other importance. For instance telegrams from Jimma are more likely to contain the word ብፍ than, say telegrams from Asmara. Again the time of the year will affect the content of telegrams as for example in September when many messages are the Happy New Year type. In order to get a more diversified and therefore a more representative material for the statistics, I have used the following table:

*available in the library of the Institute of Ethiopian Studies No. 430-Asm. 15610

AMHARIC TELEGRAMS USED FOR THE STUDY OF CHARACTER FREQUENCY

	Town	Month 1965	* Number of Telegrams	Number of Words
1.	Asmara	January	188	3987
2.	Assab	April	43	655
3.	Dessie	March	100	2618
4.	Dire Dawa	July	40	684
5.	Lekempti	February	62	1244
6.	Yergalem	February	38	1069
7.	Jimma	April	40	724
			511	10981

*Not necessarily the total number of telegrams for the particular month.

FREQUENCY OF USE OF AMHARIC CHARACTERS (STC No.65/66)

IN AMHARIC TELEGRAMS

(Prepared by Terrefe Ras - work)

(Based on a study of 511 selected telegram containing 10981 words)

	ሰ	በ	ነ	ተ	አ	ረ	መ	ሰ	ደ	የ	ሀ	ገ	ከ	ወ	ተ	ፈ	ዘ	ጠ	ቸ	ኘ	ጀ	ሸ	ጸ	ፐ	ወ	ጸ	ዘ	ሸ	ድምር	ግዕዝ
ግዕዝ	1632	1204	401	637	1731	448	1019	474	873	612	237	527	346	370	369	191	220	221	154	20	49	20	38	2	17		1	7	11820	2
ካዕብ	87	192	56	185	66	98	61	68	58	34	350	101	142	3	137	24	25	27	10	5	4	27	9	—	1	—	1	1771	4	
ሣልስ	73	151	105	49	59	121	184	46	472	4	34	53	62	52	10	69	84	4	1	5	49	27	—	5	5	—	3	1757	5	
ራብዕ	511	613	465	375	53	617	483	239	266	452	194	190	177	169	86	113	156	115	37	107	106	113	87	7	19	3	3	2	5788	3
ኃምስ	149	204	91	266	93	146	56	183	33	65	68	72	16	1	5	17	21	14	14	11	2	9	2	7	3	—	1	—	1549	7
ሳድስ	1461	778	1876	1158	800	1282	888	1566	482	608	453	438	596	518	167	272	155	254	238	202	81	96	93	18	19	45	39	—	14582	1
ሳብዕ	75	58	37	229	14	127	94	60	48	121	139	23	49	255	43	37	5	18	2	79	11	7	3	29	1	—	—	—	1564	6
ድምር	3988	3200	3031	2899	2876	2838	2785	2635	2232	1896	1475	1404	1388	1368	817	723	666	653	456	429	302	299	232	68	65	48	47	10	38831	
ግዕዝ	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28		
*ግዕዝ	4	6	1	2	3	8	5	9	12	7	13	11	14	10	18	19	17	15	16	21	22	20	24	24	23	26	25			

*አቶ አሰመርም ለገሠ አንዳገኙት
Available in the library of the Institute of Ethiopian Studies
No. 430 Asm-15610.

N. B.

$ሀ = (ሀ + ሐ + ኀ)$
 $ሰ = (ሠ + ሰ)$
 $አ = (አ + ሐ)$
 $ጸ = (ጸ + ፀ)$

ከ— 9
 ካ— 87
 ገ— 30
 ኃ— 4
 ቁ— 2
 ቋ— 2

ሯ— 1
 ታ— 5
 ጠ— 1
 ቋ— 4
 ጸ— 2

ሸ— 2
 ሸ— 14
 ሸ— 1
 ሸ— 1