National Alphabets in RDS

A summarization of key issues that confront FM broadcasters who want to include specific characters of national alphabet in Radio Data System text services.

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1 Limitations given by the RDS system

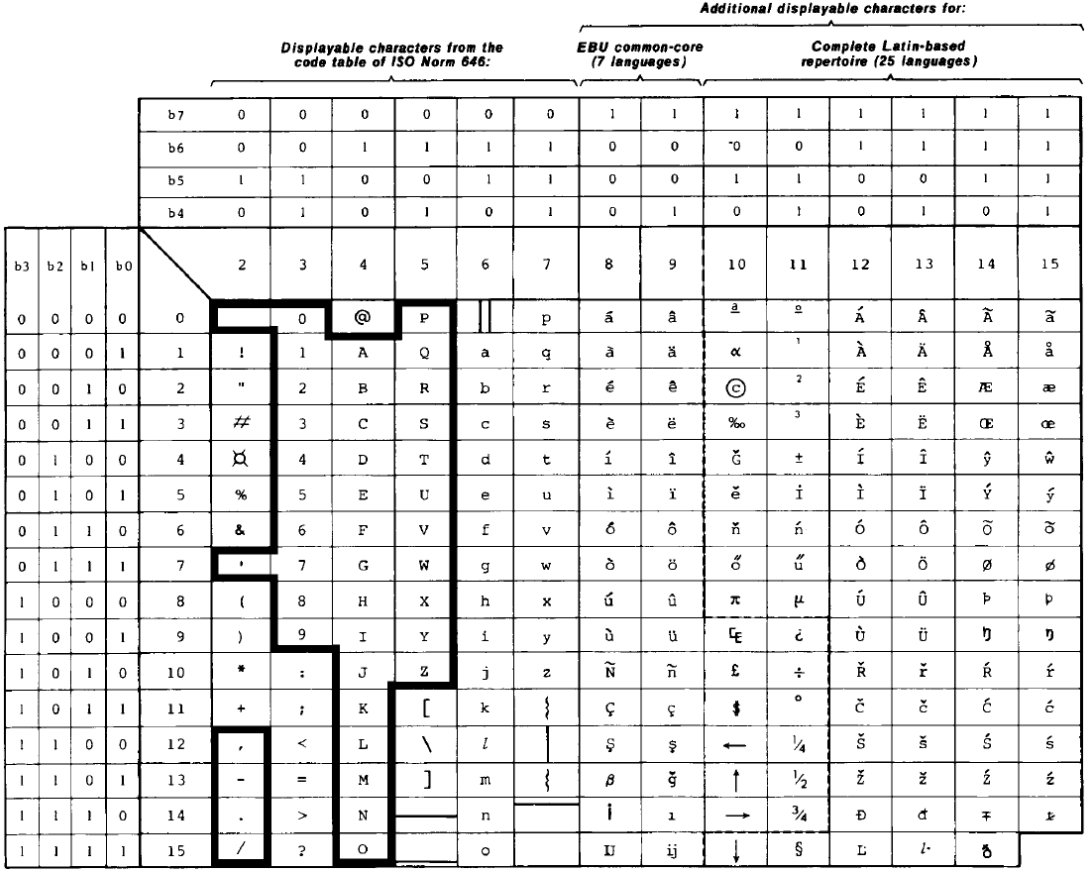
The RDS, as defined, does not support Unicode character set, which is well known from today systems. Instead of this, three code tables have been defined – default code table G0 and auxiliary code tables G1 and G2.

For the auxiliary code tables, it is necessary to provide information identifying the code table in use. Control codes have therefore been allocated to distinguish between the default (G0) and two auxiliary (G1, G2) code tables. The selection of the required code table is controlled by the transmission of one of the following pairs of code table switching characters:

- 0/15, 0/15 (0x0F, 0x0F): code table G0
- 0/14, 0/14 (0x0E, 0x0E): code table G1
- 1/11, 6/14 (0x1B, 0x6E): code table G2

These characters are transmitted within the text but they do not occupy a space in the display. They have effect on the displayable characters having the same address, and on all characters having numerically higher addresses up to, but not including, the address of another code table switching character.

In default of a code table switching character, the display coding taking effect at address 0 should be assumed to be in accordance with code table G0. Thus when using only the default code table, **no code table switching is required**.



Default code table (G0). The RDS standard points out that “low-cost” receiver may be able to display only the basic characters highlighted by the framing. This however does not automatically mean that “expensive” receiver gives better result. The “costs” are often irrelevant.

		Latin (ISO Publication 646)						EBU common-core		Part of the EBU complete Latin-based repertoire		Cyrillic etc.		Greek	
	b7	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	b6	0	0	1	1	1	1	0	0	0	0	1	1	1	1
	b5	1	1	0	0	1	1	0	0	1	1	0	0	1	1
	b4	0	1	0	1	0	1	0	1	0	1	0	1	0	1
b3 b2 b1 b0		2	3	4	5	6	7	8	9	10	11	12	13	14	15
0 0 0 0	0		0	@	P		p	ă	â	a	º	Є	ý	Π	π
0 0 0 1	1	!	1	A	Q	a	q	ă	ä	ĺ	¹	Я	Ъ	α	Ω
0 0 1 0	2	"	2	B	R	b	r	ĕ	ê	©	²	Б	ѓ	ϐ	ϱ
0 0 1 1	3	#	3	C	S	c	s	ď	ë	‰	³	Ч	Ш	ϕ	σ
0 1 0 0	4	¤	4	D	T	d	t	í	î	ă	±	Л	Ц	δ	τ
0 1 0 1	5	%	5	E	U	e	u	ì	ï	ě	İ	Э	Ю	ε	ξ
0 1 1 0	6	&	6	F	V	f	v	ó	ô	ň	ń	Ф	Щ	φ	Θ
0 1 1 1	7	'	7	G	W	g	w	ò	ö	ő	ű	Ґ	Ь	γ	Γ
1 0 0 0	8	(	8	H	X	h	x	ú	û	ŧ	ţ	Ъ	Ы	ϒ	Ξ
1 0 0 1	9	)	9	I	Y	i	y	ù	ü	Ł	ć	И	Й	ι	υ
1 0 1 0	10	*	:	J	Z	j	z	Ñ	ñ	£	÷	Ж	З	Σ	ζ
1 0 1 1	11	+	;	K	[	k	{	Ç	ç	$	°	Ќ	č	×	ς
1 1 0 0	12	,	<	L	\	l	|	Ş	ş	←	¼	Л	š	λ	Λ
1 1 0 1	13	-	=	M	]	m	}	ß	ğ	↑	½	Ђ	ž	μ	Ψ
1 1 1 0	14	.	>	N	‾	n	~	i	ı	→	¾	Ђ	đ	ν	Δ
1 1 1 1	15	/	?	O	_	o		Ŋ	ij	↓	§	Ы	ć	ω	

Auxiliary code table G1.

		Latin (ISO Publication 646)						Arabic		Hebrew		Cyrillic etc.		Greek	
	b7	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	b6	0	0	1	1	1	1	0	0	0	0	1	1	1	1
	b5	1	1	0	0	1	1	0	0	1	1	0	0	1	1
	b4	0	1	0	1	0	1	0	1	0	1	0	1	0	1
b3 b2 b1 b0		2	3	4	5	6	7	8	9	10	11	12	13	14	15
0 0 0 0	0		0	@	P	‖	p	ب	ظ	א	ו	Є	ѓ	П	π
0 0 0 1	1	!	1	A	Q	a	q	ت	ع	ב	ס	Я	Љ	α	Ω
0 0 1 0	2	"	2	B	R	b	r	ة	غ	ג	ע	Б	ѕ́	β	ρ
0 0 1 1	3	#	3	C	S	c	s	ث	ف	ד	פ	ч	Ш	ψ	σ
0 1 0 0	4	¤	4	D	T	d	t	ج	ق	ה	ף	Д	Ц	δ	τ
0 1 0 1	5	%	5	E	U	e	u	ح	ك	ו	צ	Э	Ю	ε	ξ
0 1 1 0	6	&	6	F	V	f	v	خ	ل	ז	ץ	Ф	Щ	φ	Θ
0 1 1 1	7	'	7	G	W	g	w	د	م	ח	ק	Ґ	Њ	γ	Γ
1 0 0 0	8	(	8	H	X	h	x	ذ	ن	ט	ר	Ъ	Џ	γ_1	Ξ
1 0 0 1	9	)	9	I	Y	i	y	ر	هـ	י	ש	И	Й	ι	υ
1 0 1 0	10	*	:	J	Z	j	z	ز	و	ך	ת	Ж	З	Σ	ζ
1 0 1 1	11	+	;	K	[	k	{	س	ي	ל	°	Ќ	č	χ	ς
1 1 0 0	12	,	<	L	\	l	|	ش	←	ם	¼	Л	š	λ	Λ
1 1 0 1	13	-	=	M	]	m	}	ص	↑	מ	½	Ћ	ž	μ	Ψ
1 1 1 0	14	.	>	N	‾	n	~	ض	→	ן	¾	Ћ	đ	ν	Δ
1 1 1 1	15	/	?	O	_	o	DEL	ط	↓	ן	§	Ы	ć	ω	

Auxiliary code table G2.

2 Limitations given by RDS encoders

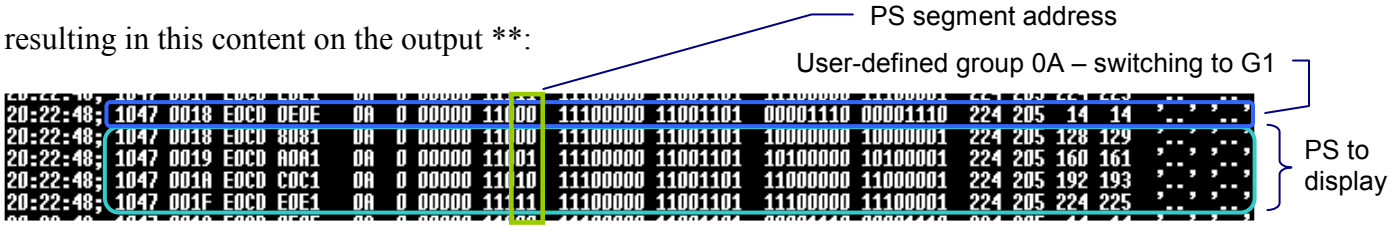
RDS encoders are usually not limiting in the issue of national characters. RDS encoders either expect some of the commonly used 8-bit coding and make the conversions necessary or they are entirely transparent so PC software (broadcast automation system) can take full responsibility for correct coding and conversions. For example, in Magic RDS the option can be found in Options – Preferences – Local settings.

RDS encoders often lack direct support for code table switching, i.e. they do not switch the receiver to any auxiliary code table (G1, G2) themselves. As a workaround, particularly for testing purposes *, the switching can be provided via one user-defined group but the encoder must allow synchronization between transmission of that group and first group of the text desired.

For example, in PIRA32 RDS encoder appropriate configuration for PS transmitted in code table G1 would be

```
UDG1=0000E0CD0E0E
GRPSEQ=X0
```

resulting in this content on the output **:



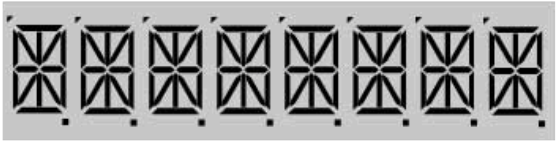
Notes: * In some cases, this kind of use may violate with AF coding.
** Picture taken from RDS Spy decoder.

3 Limitations given by RDS receivers

Together with the absence of Unicode coding in RDS, the receiver itself is the most limiting element in entire chain, in relation to correct showing of the national characters. Implementation of the RDS in various receivers differs brand to brand and model to model, while **the broadcaster may compose only one text for all**.

3.1 Receivers with 14-segment LCD display

Even though percentage of the receivers equipped with this kind of LCD display gradually decreases, they are still frequent especially as home stereos or car radios.



8-character 14-segment LCD display

This LCD can show only a limited set of characters from the basic region. For other characters, depending on the receiver type, two situations may occur:

- Characters that cannot be showed directly, are converted to the nearest displayable characters, if such conversion is possible and meaningful. In that case the text usually stays readable.
- Characters that cannot be showed directly or characters that are less frequent, have no image defined in the receiver's memory so they appear on the LCD as blank spaces. The text becomes hard to be read.

3.2 Code table switching not supported

Several problems have been noticed on receivers when receiving code table switching sequence. These problems include:

- Blinking of first segment of the text. This problem is caused due to receiver's misinterpretation of the code table switching codes as characters to be displayed. Since no displayable character is assigned to these codes, they are showed as spaces and are rewritten by original text after receiving of the next text group. This behavior continuously repeats.
- The text is not showed at all. This problem relates to the previous. The receiver waits for stable reception of the text which never occurs.
- The text is showed correctly but the code table switching codes are completely ignored, causing the text to be showed in the default coding (G0) regardless of its real coding (G1, G2). This is the most frequent case, meaning that auxiliary code tables (G1, G2) practically cannot be used for coding of common RDS text services (PS, RT). An argumentation, that there could be local variations of receivers able to handle this coding, loses importance and reliability as the market becomes globalized.

3.3 Conversion of additional characters not supported

Today's equipment usually combines the FM receiver with other functions. The device incorporates some of the usual character code tables, which of course differ from the RDS code tables. Unfortunately if no conversion is made inside the receiver between different code tables, the result is similar like selecting wrong coding when viewing a text file on a PC – there are wrong characters showed on positions of the additional (national) characters.

4 Practical test of receivers

For practical test, five RDS receivers have been chosen, which represent different age and class of equipment. These are Apple iPod A1320, Sony XR-C6220R, Nokia HS-12W, Panasonic SA-AK320 and Conrad RDS Manager.

Reference RDS data has been broadcasted via PIRA32 RDS encoder and RF signal generator.

4.1 Code table switching test

Within this test, the PS (Program Service name) has been transmitted as a sequence of following bytes from the additional character set region:

0x80	0x81	0xA0	0xA1	0xC0	0xC1	0xE0	0xE1

Each PS sequence has been preceded by the code table switching group, successively G0, G1 and G2.

Results of the test are showed on the next page.

Expected results:

G0:	ā	à	ª	α	Á	À	Ã	Å
G1:	ă	ą	º	ĺ	€	Я	Π	α
G2:	ﺩ	ﺫ	✖	ב	€	Я	Π	α

Test results:

Receiver	G0	G1	G2	LCD output *	Notes
iPod	**OK**	**Failed**	**Failed**		
Sony	**OK**	**Failed**	**Failed**		G0 – converted to nearest displayable characters.
Nokia	**Failed**	**Failed**	**Failed**		PS not showed at all!
Panasonic	**Failed**	**Failed**	**Failed**		???
Conrad	**Failed**	**Failed**	**Failed**		National characters showed as space. If displayable characters are being transmitted, the first two characters blink in presence of code table switching codes!

* Note:
All receivers ignore the code table switching codes. They always use the default code table (G0) although another code table is being indicated. Thus the LCD output was the same for all code tables.

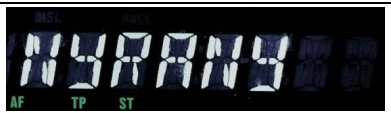
4.2 Test of the default code table

Within this test, the PS (Program Service name) has been transmitted as a mixture of basic and additional characters from the default code table G0.

Expected result:

Nýřany

Test results:

Receiver	Default code table (G0)	LCD output	Notes
iPod	OK		
Sony	OK		Converted to nearest displayable characters.
Nokia	Failed		Conversion missing between G0 and internal code table.
Panasonic	Failed		National characters showed as space.
Conrad	Failed		National characters showed as space.

5 Conclusion

Nowadays, broadcasters can choose one of two options with respect to the national character set:

- Keep the text almost perfect but unreadable on most receivers.
- Keep the text readable on all receivers but possibly not perfect.

A receiver, that entirely supports the character coding as defined in the RDS standard, probably does not exist. An assumption, that recent receivers give getter results than older types, is valid only partially.

Auxiliary code tables (G1, G2), although they are defined, are implemented rarely. Broadcasters can practically use only the default code table (G0). Broadcasters may realize own tests and research for making a decision if the use of the additional (national) characters brings more benefits than problems. Based on this decision, appropriate characters can be converted before transmission, either to original G0 or to the nearest basic characters.

Any future revision of the RDS standard must allow the broadcasters to solve the problems above once forever. For future revision of the RDS standard, the author recommends defining optional “shadow” text services at least for PS (Program Service name) and RT (Radiotext), based on Unicode character set. Both the existing and the “shadow” text services will be transmitted with the same or similar content, but they will differ in use of national characters – in this case only the “shadow” services will use national characters. This would enable the broadcasters to guarantee good readability on old or simple receivers and provide a possibility of perfect Unicode-based text on new receivers.