

3

RDS Features Serving as Tuning Aids

3.1 Introduction

In this chapter, RDS features that help the tuning functionality of FM receivers are introduced. In this connotation, a feature in RDS is considered to be something that gives a distinctive functionality. Originally in the earliest versions of the specification, these tended to be defined into a single RDS group such as RadioText, which is described in Chapter 4 (although there are notable exceptions such as PI, which is described in this chapter). But, as the specification was enhanced, some features were defined that make use of more than one group to be transmitted (e.g. Radio Paging, which is described in Chapter 8) to obtain full functionality.

Many of these features are considered to be included in the minimum set of RDS features that would be implemented initially by a transmission operator.

3.2 Basic RDS Features

The RDS specification, EN 50067:1998, defines a number of RDS group types that are generally reserved for a particular application. The type 0A group—basic tuning and switching information—is a special case, designed to carry the fundamental components of RDS all together in a single group that will be transmitted frequently to convey many pieces of information to an RDS receiver to enable it to perform a considerable number of tuning functions. These fundamental components, known as features, allow a degree of

automatic tuning in an RDS receiver and allow it to present tuning-related information to the user. The type 0A group contains all of the following RDS features: Alternative Frequency (AF), Decoder Information (DI), Music Speech (MS), PI, Programme Type (PTY), Traffic Announcement (TA), and Traffic programme (TP). The type 0B group contains the same features except the AF feature [1].

The implementation of the type 0 groups in any RDS transmission is essential, and not optional—unlike many of the other possible groups in RDS—because it carries vital information required for automated tuning of an RDS receiver.

From these basic RDS features serving as tuning aids, it is useful to initially consider AF, PI, PS, and TP. They can be seen in various locations within the type 0A group, as shown in Figure 3.1. Furthermore, PI and TP can be found in *all* other groups to provide immediate information to an RDS receiver from every single group decoded.

The type 0B group has a very similar structure, but there is a simple difference in block 3, as shown in Figure 3.2. In block 3, the AF feature is not used, so it is replaced by a second PI code. This group is normally used by single-service RDS transmissions, where there is no need for an AF list because there are, indeed, no alternates.

3.3 Programme Identification—PI

The PI code is transmitted in block 1 of *every* single RDS group. PI is a machine-readable code that is not intended for direct display. It is uniquely allocated to each individual programme service within a geographical area to enable it to be distinguished from all other programme services. (For more detail about PI coding, see Appendix F.) Irrespective of frequencies used, transmissions with identical PI codes in any given area must have the *identical* audio programme. A receiver may therefore freely switch between two different transmissions with the same PI code in order to track optimum reception, assured that programme audio will be identical on both transmitters.

One important application of the information contained in the PI code is to enable an RDS receiver to automatically search for an alternative frequency in case of bad reception of the programme to which the receiver is tuned; the criteria for the changeover to the new frequency would be the presence of a better signal having the *same* PI code.

The PI code consists of 16 bits and is usually referred to by four hexadecimal characters, or nibbles, as shown in Figure 3.3.

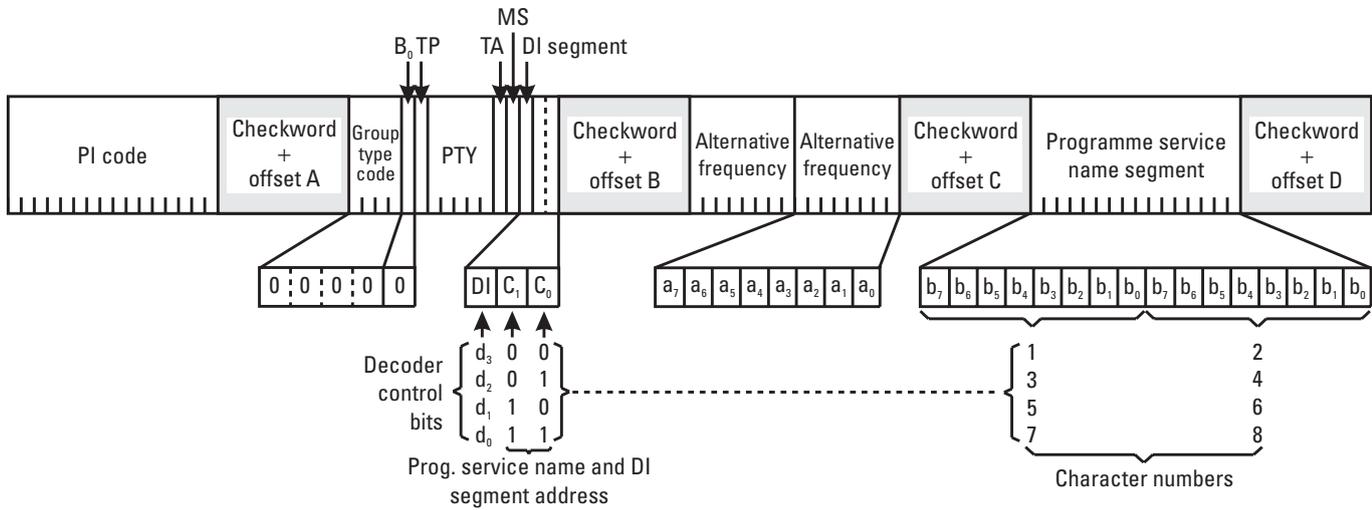


Figure 3.1 Type 0A group, showing the disposition of features carried. (Source: EBU.)

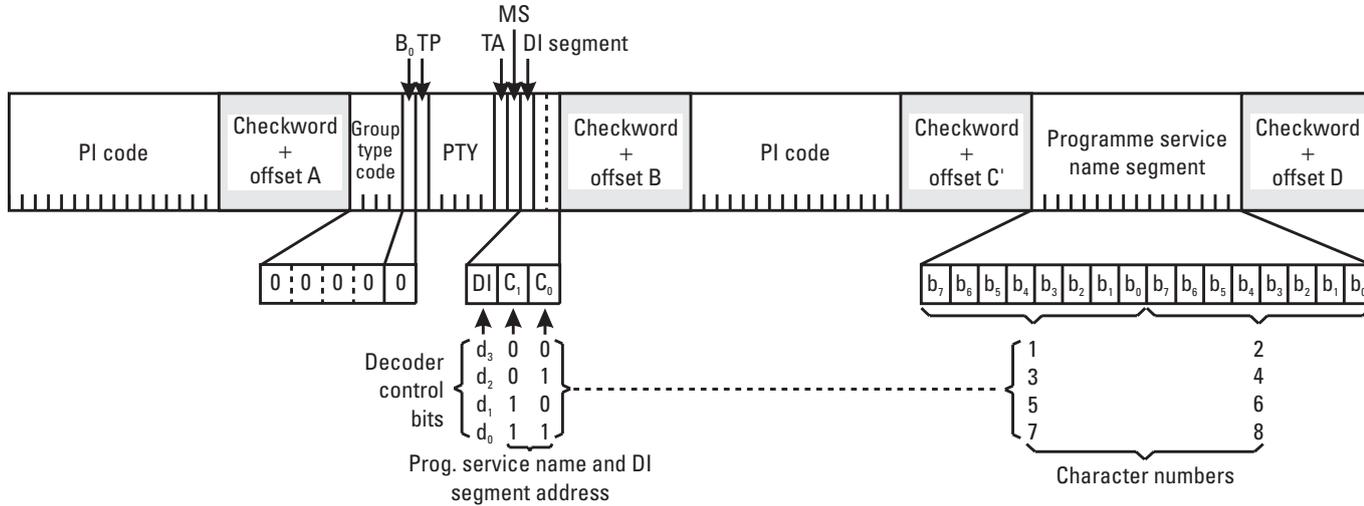


Figure 3.2 Type 0B group, showing the second PI code in place of the AF feature. (Source: EBU.)

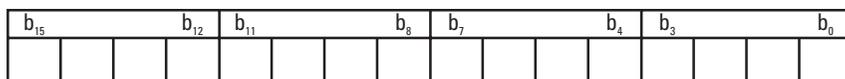


Figure 3.3 PI code structure. (Source: EBU.)

PI codes assigned to programme services are invariant, and other than changing the second nibble (regional element) in accordance with the specific rules, it must not be changed as part of regular radio programming. Furthermore, when cross-referring to other services, the PI code of referenced services is transmitted in block 4 of type 14 groups (see Chapter 5).

3.3.1 Broadcasting Conventions

PI codes must be allocated so that two different services do *not* transmit the same PI code in the same area. As part of this allocation process, the first nibble (hexadecimal character) is a Country Identifier, signifying the country of origin of the broadcast (not necessarily the country in which a transmitter is located), as shown in Figure 3.4. The country/area code allocations are given in the RDS specification EN 50067:1998, Annexes D and N [1], and in Appendix G of this book. The PI code allocations for Europe are shown in Figure 3.5.

In Europe, most broadcast networks are in fact services comprised of more than one transmitter which, at times, separate or split in order to offer regional information or programmes. Each of these regions must be provided

Area coverage code	L	I	N	S	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
HEX	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F

I = International	The same programme is also transmitted in other countries
N = National	The same programme is transmitted throughout the country
S = Supra-regional	The same programme is transmitted throughout a large part of the country
R1 to R12 = Regional	The programme is available only in one location or region over one or more frequencies, and there exists no definition of its frontiers
L = Local	Local programme transmitted via a single transmitter (only) during the whole transmission time

Figure 3.4 Coverage area: hex codes used in the second nibble of the PI code. (Source: EBU.)



Figure 3.5 PI country code allocations for Europe. (Source: EBU.)

with a unique PI code by allocation of a different regional code in the second element. The regional element must be in the range 4-F hex. Services having identical first, third, and fourth elements, and a regional element in the range 4-F hex are said to be generically related or regional equivalent services. Up to 12 services, each using one of the regional codes (4-F hex) may be associated in this way. During the times when *all* regions are carrying common programmes, it is permitted for the services to change the regional element of the PI code to either 2 or 3 hex on each regional service. If the code is changed in this manner, all regions should ideally join/split at the *same* time. Partial splits/joins will cause undesirable effects for some listeners. This is the only change of PI code

normally permitted. Changing PI codes is *not* permitted on programme services used as part of an Enhanced Other Network (EON).

Although within a country code area, PI codes *may* be reused at geographically separated areas, it is preferable that each service be allocated a unique code. RDS receivers use the PI code as addresses against which to store programme attributes (Programme Service name, list of alternative frequencies, etc.). Use of the same PI code by more than one programme service would probably cause data about one service to be misassociated with another having the same PI code.

To prevent having to reuse PI codes and yet still be able to associate together more than 12 regional equivalent services, the Extended Generic (EG) feature should be used. The word generic has a somewhat special meaning in RDS and involves some very complex ideas, which require a very full appreciation of how broadcasters view their services. Furthermore, sometimes they transmit common programmes in a network and this must be signalled to an RDS receiver. A more detailed explanation can be found in the EBU/RDS Forum document BPN 009: RDS Guidelines [2].

In this case, PI codes that have the extended generic indicator (EG) flag set, and are identical in the first and third elements only, and regional elements in the range 4-F hex, are also regional equivalent services to each other. Up to 192 (12×16) such services may be grouped in this way.

3.3.2 Reception

The PI code is arguably the single most important feature of RDS. It uniquely identifies a programme service, within any geographical area, where broadcasts sharing the same PI code are guaranteed to be carrying identical programme audio. Although there are many designs possible for an RDS receiver, evaluation of the PI code is fundamental to operation.

In any receiver with preset memories, it is essential for the PI code of the broadcast to be stored in nonvolatile memory when a service is assigned to a memory location. If no signal with the correct PI code is available, on the last tuned frequency or AFs, when a preset is chosen, the receiver should scan the FM band, stopping on each receivable RDS service and evaluating the PI code.

The correct transmission to select is that which gives the best signal with a PI code matching that recalled from memory. If no service with a matching PI code can be found, a receiver should select a transmission with (in order of priority) a PI code identical in the first, third, and fourth elements or a PI code identical in the first and third elements only. Although accepting these transmissions as regional variations of the wanted service, under no circumstances

should the PI code stored in preset memory be overwritten by any other PI code.

An RDS receiver must always evaluate the PI code and confirm it is correct before it remains tuned to a different transmission. Usually, switching between two different transmissions should occur only when PI codes are identical in all four nibbles. Optionally, a receiver may provide a mode that enables receivers to switch automatically to other regional variants of the same service.

3.4 Programme Service (PS) Name

The PS name is an eight-character alphanumeric label transmitted by the broadcaster to identify to the listener the name of the tuned service. It is not intended for automatic tuning purposes. The PS name is transmitted two characters at a time in either the type 0A or type 0B groups. (See Figures 3.1 and 3.2 above.) A complete PS name requires a minimum of four groups, which at the recommended rate takes just one second to be transmitted. As the reception of a PS name takes a minimum of one second, and even longer in adverse reception conditions, receivers may store the PS name to allow instant recall upon the user accessing a preset memory. Since broadcasters may choose to transmit PS names in either type 0A or 0B groups, receivers must be capable of using both transmission methods.

PS names can also be carried as part of the EON data and then provide the PS name of the cross-referenced programme services.

The PS name should only be used as a static feature, but it may occasionally change. For example, regional services may carry their own PS name during the day when they originate their own programmes. However, the PS name is changed when they are transmitting a common programme originated by one of these broadcast services during the evenings and nights.

Due to these design parameters for PS, the use of the PS feature to transmit text other than a single eight-character representation of the Programme Service name is not permitted. If a broadcaster wishes to transmit more programme service information, programme-related information, or any other text, then the RadioText feature provides the capability to achieve dynamic text possibilities. The RDS Forum has been instrumental in keeping media regulators informed about the correct use of PS, which has, unfortunately, been incorrectly implemented by several broadcasters who have not realised the importance of these design parameters for PS [3].

Appropriate use of spaces, punctuation, and combinations of uppercase/lowercase characters and accented characters should all be used to improve

readability of the PS name. For example, in the United Kingdom, the BBC uses >_BBC_ R4_< for the BBC Radio 4 network PS and classic FM uses >Classic_< for its PS. The characters to be used for PS are shown in the RDS specification EN 50067:1998 Annex E, which indicates a “limited character set” that may only be available to a low-cost receiver, using only uppercase characters together with numbers and a few punctuation marks. The limited character set for display is indicated in a footnote to Figure E1 in Annex E of the RDS specification (see Appendix I, Figure I.1). Receivers capable of only displaying the limited character set must convert the lowercase characters in columns/rows 6/1–7/10 to their column 4 and 5 uppercase character equivalents and convert accented characters in columns 8-15 to their non accented equivalent. For example, a low-cost receiver would need to convert the received character “a” to “A” for display; it would also have to convert “ä” to “A” and convert other characters such as “é” to “E.” A midrange receiver displaying lowercase characters in columns 6 and 7 may still be required to convert received accented characters such as “ñ” to “n” for display. Clearly, receivers capable of displaying the full character set will provide a superior presentation.

Broadcasters have to be aware that not all receivers’ displays will support the full code table, and may only support the limited character set.

Even though PS has constrained design parameters, to achieve very reliable PS reception and to provide a safe invariant display, it can be employed in a receiver to offer exceptionally user-friendly performance. For example, a dual front-end tuner car radio from Becker (see Figure 3.6) uses incoming PS information to derive and generate a three-character soft label for a number of preset buttons. This allows the user to see a description of other radio stations with some identification, which is better than seeing a preset number label such as “1,” “2,” “3,” and so on.



Figure 3.6 Becker car radio using PS-derived soft labels for programme selection buttons. (Source: Becker.)

3.5 Alternative Frequency List—AF

The purpose of the AF list is to facilitate the automatic tuning of an RDS receiver. The AF list indicates carrier frequencies on which the specified service is broadcast. AF lists may be broadcast for the tuned service and also for other services using the EON feature. Generally, at any one location, only a few (or even none) of the frequencies indicated will carry the intended service at good signal strength. Receivers must ascertain the suitability of each frequency in the list by evaluating the signal quality and then decoding the PI code to check that there is an exact match before switching frequencies automatically.

AFs for the tuned network are broadcast two codes at a time, in block 3 of type 0A groups, according to codes given in Tables 3.1 and 3.2.

AF lists for cross-referenced services are carried in variants 4, 5, 6, 7, 8, and 9 of type 14A groups.

Ideally, AF lists should be as short as possible and contain *only* the frequencies of immediately adjacent transmitters. Broadcasters may achieve this by installing RDS encoders at each transmitter site, with an individual appropriate list of frequencies. This coding method, known as *Method-A*, is the most widely used and suitable for lists not exceeding 25 frequencies. At the recommended repetition rate for the transmission of type 0A groups (i.e., four groups per second), a list with the maximum of 25 frequencies will take less than four seconds to transmit in its entirety. Figure 3.7 shows an example Method-A list and explains the format when an even number of frequencies are in the list, necessitating the use of the filler code (which can be ignored by the receiver).

A second way to transmit AFs is provided where it is not possible to restrict the list to fewer than 25 frequencies, or where it is required to indicate frequencies that belong to different regions that at times carry different programmes. In this coding of alternative frequencies, known as *Method-B*, all

Table 3.1
VHF Code Table

Number	Binary Code	Carrier Frequency
0	0000 0000	Not to be used
1	0000 0001	87.6 MHz
2	0000 0010	87.7 MHz
:	:	:
:	:	:
204	1100 1100	107.9 MHz

Table 3.2
Special Meanings Code Table

Number	Binary Code	Special Meaning
0	0000 0000	Not to be used
205	1100 1101	Filler code
206	1100 1110	Not assigned
:	:	:
223	1101 1111	Not assigned
224	1110 0000	No AF exists
225	1110 0001	1 AF follows
:	:	:
249	1111 1001	25 AFs follow
250	1111 1010	An LF/MF frequency follows
251	1111 1011	Not assigned
:	:	:
255	1111 1111	Not assigned

transmitters broadcast in sequence, a series of transmitter-related lists that are organised in frequency pairs, with the particular transmitter frequency always repeated in each pair as a reference together with one of the respective alternative frequencies of that transmitter.

The particular way in which the data is organised within block 3 of type 0A groups enables a receiver to deduce whether Method-A or Method-B coding is being used and, in the case of Method-B, to derive the shorter lists

F_1	F_2	Explanations
# 6	89.3	Total number (6) of frequencies in this list (excluding the Filler code) 89.3 MHz is the frequency of a "main transmitter"
88.8	89.0	88.8 MHz and 89.0 MHz are AFs of tuned frequency (possibly re-broadcast transmitters)
99.5	101.7	99.5 MHz and 101.7 MHz are AFs of tuned frequency (possibly re-broadcast transmitters)
102.6	"F"	102.6 MHz is an AF of the tuned frequency (possibly re-broadcast transmitter) and Filler code

Figure 3.7 Example of an AF list using Method-A. (Source: EBU.)

appropriate to each transmitter within the network. As the complete list of frequencies carried by Method-B may be very long, a complete cycle of information may take up to two minutes (or even longer in poor reception conditions) for a receiver to acquire.

Clearly, receivers must be able to detect and use AF lists coded in either the Method-A or Method-B protocols. The rules governing Method-B transmissions are complex and beyond the scope of this book, but Figure 3.8 gives a flavour of the possibilities.

The presence of a frequency within an AF list does not guarantee that the frequency will provide a suitable signal in any particular area, and especially does not guarantee that a transmission on a frequency will be that intended by the broadcaster. In areas where frequency planning or regulation of broadcasting is inadequate, a particular frequency may be reused for quite different services in close proximity. It is essential therefore that the receiver, before accepting a new frequency, tunes to the intended frequency to check and confirm the PI code is the one expected. Only if the PI code matches the one intended, should the receiver accept the frequency as the new tuned frequency. Receivers should reject frequencies where there is no detected PI code or the wrong PI code.

When retuning to an alternative frequency, a receiver will inevitably produce, in the case of a single front-end unit, a short audio interruption on the

F_1	F_2	Explanations
# 11	89.3	Total number (11) of frequencies for tuning frequency: 89.3 MHz
89.3	99.5	$F_2 > F_1$; 99.5 MHz is an AF of tuned frequency 89.3 MHz and is the same programme
89.3	101.7	$F_2 > F_1$; 101.7 MHz is an AF of tuned frequency 89.3 MHz and is the same programme
88.8	89.3	$F_2 > F_1$; 88.8 MHz is an AF of tuned frequency 89.3 MHz and is the same programme
102.6	89.3	$F_2 < F_1$; 102.6 MHz is an AF of a regional variant of tuned frequency 89.3 MHz
89.3	89.0	$F_2 < F_1$; 89.0 MHz is an AF of a regional variant of tuned frequency 89.3 MHz
# 9	99.5	Total number (9) of frequencies for tuning frequency: 99.5 MHz
89.3	99.5	$F_2 > F_1$; 89.3 MHz is an AF of tuned frequency 99.5 MHz and is the same programme
99.5	100.9	$F_2 > F_1$; 100.9 MHz is an AF of tuned frequency 99.5 MHz and is the same programme
104.8	99.5	$F_2 < F_1$; 104.8 MHz is an AF of a regional variant of tuned frequency 99.5 MHz
99.5	89.1	$F_2 < F_1$; 89.1 MHz is an AF of a regional variant of tuned frequency 99.5 MHz

Figure 3.8 Examples of AF lists using Method-B, along with their meaning. (Source: EBU.)

order of a few milliseconds. Checking a PI code, however, will take at least 100 milliseconds, during which time it is possible for a burst of incorrect programme to be heard, should the particular frequency being tested be other than the intended programme. Manufacturers should adopt an intelligent process as a background activity to validate each frequency in the AF list. This will ensure that a receiver has available for use, when required, a frequency with an optimum audio quality and with the correct PI code. Unwanted bursts or breakthrough from other programmes (of the wrong PI code) and audible mutes should be avoided. Dual-tuner receivers may have an advantage in AF list evaluation as the checking of PI codes may be done by the second tuner while the first tuner continues to provide an uninterrupted audio programme for the listener.

Some broadcasters may include frequencies of services in their AF lists—simultaneously broadcast on AM perhaps, where there is no suitable FM transmission. In this case, it is not possible to confirm the frequency that carries the intended programme as no PI code is transmitted on normal AM frequencies. Use of AM frequencies is probably only viable where the AM tuner part of the receiver is separate from the FM one. This would allow a receiver, while the AM tuner is providing an audio programme, to use the FM tuner to perform RDS processing and remain active to allow the earliest possible return to an FM transmission.

3.6 Traffic Programme (TP) Flag

The RDS traffic information service allows listeners to receive traffic reports even if listening to a CD/cassette, or with the receiver volume turned down or muted. This service makes use of two flags: the TP and TA flags. The latter is described more fully in Chapter 6; here, the tuning aspect of the TP flag is considered. The TP flag is carried in block 2 of *every* group type and in block 4 of type 15B groups. If the TP flag is set to /1/, this indicates that the tuned programme service provides the RDS traffic service. Broadcasters must *not* set the TP flag to /1/ unless the TA is also *dynamically* controlled [1].

Programme services that do *not* provide traffic services with a switched TA flag, but instead cross-reference via EON services that do, indicate this by setting the TP to /0/ and the TA to /1/ on the service. When a listener selects the RDS traffic service feature, the receiver uses the status of both the TP and the TA flags to determine whether or not the tuned service can provide the traffic information service itself, or alternatively in the case of an EON-capable receiver, via a cross-referenced service.

The TP flag can be used by an RDS receiver, since it is in every RDS group, to easily evaluate the availability of the RDS traffic service when checking a frequency as part of the automatic tuning capability. If the tuned service does not provide the RDS traffic service feature, an RDS receiver should indicate this to the listener in some way. Options include the following:

- Visually on the display or audibly by a bleep. This is particularly useful when going away from a service and signal strength weakens to the point where the TP flag status is becoming uncertain.
- The receiver may automatically start to seek for an alternative service able to provide a traffic service.

Alternatively, the receiver could allow the user the option of continuing to listen to the currently tuned service without the traffic service, or manually initiating a search for an alternative service. The options provided might be different, depending on how the user is currently operating the receiver. For example, a routine may be as follows:

- If the RDS traffic information service is selected while the user is listening to a CD/cassette, the receiver may automatically seek and tune to a service capable of providing a traffic service, without either beeping or requiring a listener to manually initiate a search.
- If listening to the radio when traffic information is selected, the receiver should alert the listener visually or with a brief audible warning if the traffic service is unavailable, but not automatically retune. The user then has the option to initiate a seek for another traffic service programme, if required, or to continue listening to the tuned service but without a traffic service.

The same routine should be adopted if, while tuned to a service that was offering a traffic information service, the status of the TP/TA flags changes and indicates that a travel service is no longer available. Interference on areas of poor reception will mean that the TP and/or the TA flag may at times be read unreliably. It is important that the status of TP and TA flags be evaluated over several groups, and that momentary switching be avoided as the result of short-term signal fluctuations.

A full description of the interaction of TP flags, TA flags, and EON is given in Chapter 6.

3.7 Slow Labelling Codes

The RDS specification contains some additional slow labelling codes that are used to support various features. These are specified to be carried in the type 1A group at a much slower rate than the main feature groups; for example, once per minute. The type 1A group also contains the functionality of the PIN feature (see Chapter 5), as shown in Figure 3.9.

3.7.1 Extended Country Code (ECC)

The ECC feature was built into the RDS specification some time after the original publication of the specification, because originally it had been designed only for Europe and the limited number of country identifier codes (only 15 different codes, 1-F hex) could easily be shared across the geographical area considered. Note, for example, in Figure 3.5 that E hex is shared between Sweden and Spain. The use of RDS has grown considerably since then and, indeed, the need to accommodate newer emerging countries has resulted in the ECC feature, which is now an important part of the full implementation of several other features. When widely implemented, this feature allows receivers to initialise automatically for country-specific applications; therefore, broadcasters are being encouraged to implement this feature.

The ECC feature, when read in conjunction with the country code part of a PI code, forms a *unique* Country Identifier. This may be used by a receiver to automatically select country-specific applications; for example, PTY language tables, which are different according to the broadcaster's choice of RDS or RBDS. To support this functionality, the ECC, which consists of 8 bits transmitted in block 3 of type 1A group's variant 0 (as shown in Figures 3.9 and 3.10), should be transmitted at least once per minute.

Returning to the example of Spain and Sweden, Romania also uses E hex in the allocated country PI code. However, each country is assigned a different Extended Country Code: Romania = E1, Spain = E2, Sweden = E3, which taken together with the country code element of the PI code provides a unique Country Identifier. Full listings of the ECC and PI country/area codes are given for European countries in EN 50067:1998 Annex D, and for the rest of the world in Annex N (see also Appendix G of this book) [1].

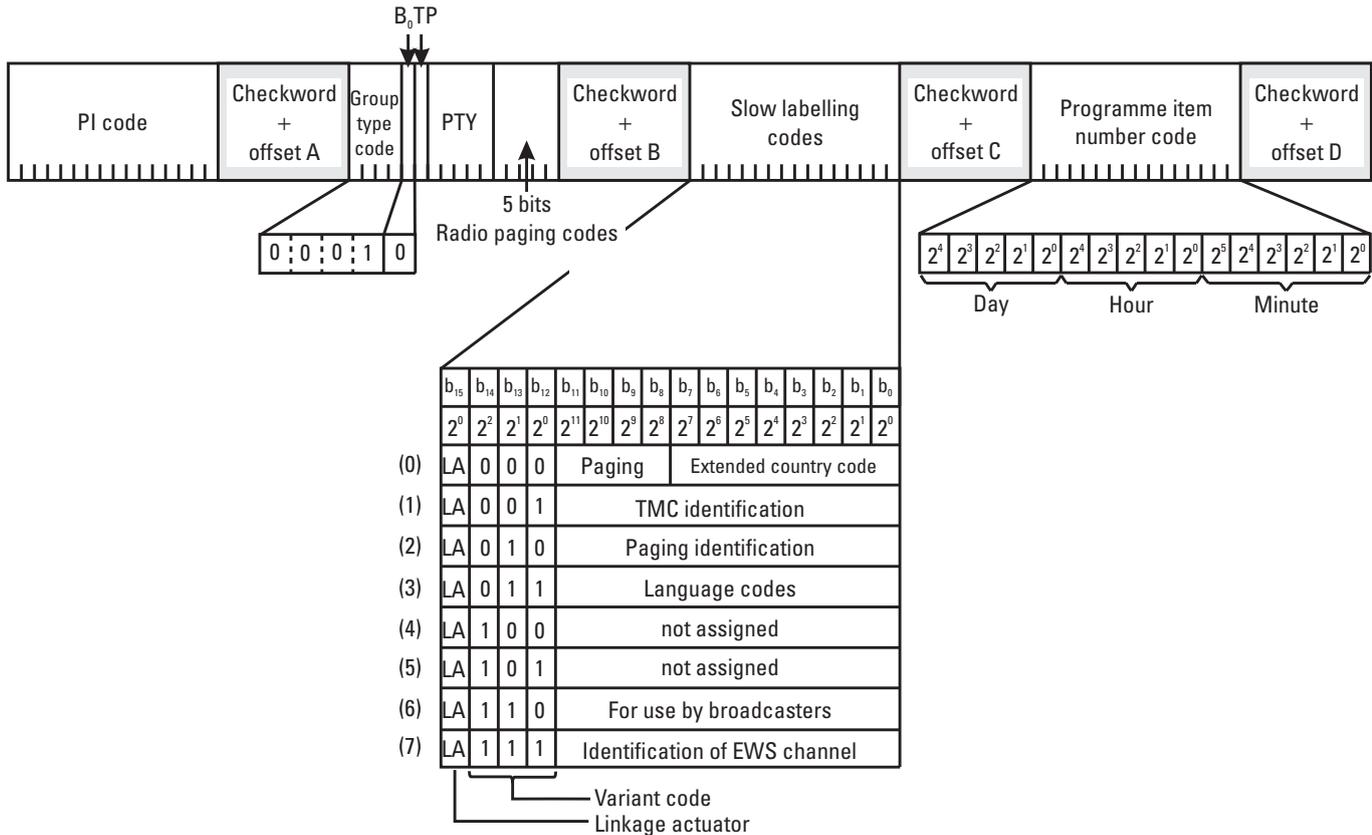


Figure 3.9 Type 1A group showing among other slow labelling codes the ECC and language identification features. (Source: EBU.)

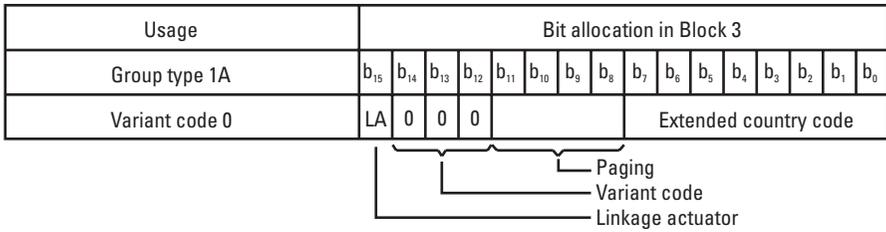


Figure 3.10 ECC bits in type 1A groups, variant 0. (Source: EBU.)

3.7.2 Language Code

Another enhancement that remains optional, but which is easy to transmit and could lead to enhanced receiver performance, is the language code, also carried using 8 bits in type 1A groups, variant 3 (as shown in Figure 3.11). Language identification may be used to signal the spoken language of the current programme on a service. The feature may be of interest not only in multilingual countries but also for visitors to help locate programmes in their preferred language.

Broadcasters may automatically control the language code by including a data field in their RDS programme scheduling system, and this could then be used to control their RDS encoders automatically. They should be aware that the normal repetition rate for type 1 groups to convey the PIN feature is approximately once per minute and that the expected rate for language identification will go down if several variants of type 1 groups are utilised. It is, however, recommended to transmit variant 3 if the language code is implemented at least once every two seconds. This makes the feature unsuitable for search tuning.

The language codes, described as two hex numbers, are specified in EN 50067:1998, Annex J [1].

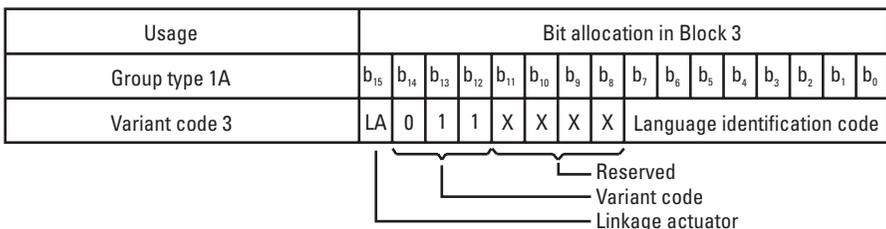


Figure 3.11 Language code bits in type 1A group, variant 3. (Source: EBU.)

References

- [1] CENELEC, EN 50067:1998-Specifications of the Radio Data System (RDS.) for VHF/FM broadcasting, European Committee for Electrical Standardisation (CENELEC), 35B rue de Stassart, B-1050 Brussels, April 1998.
- [2] EBU /RDS Forum: BPN 009-Radio Data System (RDS) Guidelines, to be published in Autumn 1998.
- [3] RDS Forum Statement, sent with letter DT/969-S/DK dated Feb. 26, 1996, RDS Forum Statement, sent with letter DT/3255-S/DK dated Dec. 9, 1997