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Open Data Applications (ODA)

9.1 Introduction

This chapter describes the Open Data Applications (ODA) feature that was developed by the RDS Forum to meet a service provider requirement—to use RDS for data services that would be developed *after* publication and during the relatively long life of the RDS and the RBDS standards. A particular motivation was to facilitate the development of RDS-TMC (within the CEN standardisation processes) using ODA. But other uses have already emerged—some where a service provider wishes to make the use public and others where the service details are kept private, perhaps because it will be offered as a subscribed service.

9.2 The Concept and Availability of the ODA Feature

The ODA feature was developed to allow data applications not previously specified in EN 50067:1992 to be conveyed in an RDS data stream with minimal difficulty. The ODA feature, specified in EN 50067:1998, permits a number of predetermined groups types to be used, and these have to be indicated in any RDS transmission using the ODA application identification (AID) feature to allow decoders to monitor for them and then decode the relevant data. A wide variety of groups are available for use by ODA data services, and these may be selected by a transmission operator at his or her convenience. The service is identified in the associated type 3A groups in the *same* RDS data stream. Group types shown in Table 9.1 are available for ODA. Some can only

Table 9.1

ODA Group Availability, Signalled in Type 3A Groups

Group Type	Application Group Type Code	Availability for Open Data Applications
	00000	Special meaning: not carried in associated group
3B	00111	Available unconditionally
4B	01001	Available unconditionally
5A	01010	Available when not used for TDC
5B	01011	Available when not used for TDC
6A	01100	Available when not used for IH
6B	01101	Available when not used for IH
7A	01110	Available when not used for RP
7B	01111	Available unconditionally
8A	10000	Available when not used for TMC
8B	10001	Available unconditionally
9A	10010	Available when not used for EWS
9B	10011	Available unconditionally
10B	10101	Available unconditionally
11A	10110	Available unconditionally
11B	10111	Available unconditionally
12A	11000	Available unconditionally
12B	11001	Available unconditionally
13A	11010	Available when not used for RP
13B	11011	Available unconditionally
	11111	Special meaning: temporary data fault (Encoder status)

be used on the condition that other groups are not in use in the multiplexing of RDS groups of a particular transmission.

9.3 Indicating an ODA Transmission

Type 3A groups are used to indicate the inclusion of an ODA in any particular RDS data stream and inform a receiver/decoder about the ODA by providing

both an AID and information as to which group the data service is carried in for the particular transmission being received. As a result, the receiver/decoder is able to invoke the correct software decoder for that application and monitor the chosen group type for data relevant to that ODA service.

The type 3A group shown in Figure 9.1 comprises three elements: the application group type code used by that application (using 5 bits), 16 message bits for the actual ODA, and the AID code (this uses 16 bits). Applications that actively utilise both type A and B groups are signalled using two type 3A groups. The type 3A group is usually transmitted at a relatively low rate, perhaps one group per minute, to provide information needed when a receiver/decoder is switched onto the relevant RDS data stream—either newly switched on or vectored from another channel. The data service provider has to decide how frequently the information contained in type 3A groups is needed, with the view of minimising the use of this group and avoiding taking up unnecessary groups. Generally, it is common practice to try to achieve about one type 3A group per minute for services that expect receiver/decoders to be used in nondedicated applications. However, closed user group applications with dedicated receiver/decoders may use a more infrequent use of type 3A groups.

The application group type code includes two special status conditions that may also be indicated by the following:

- The code 00000—"Not carried in associated group."
- The code 11111—"Temporary data fault (Encoder status)."

The former status is used to "prepare" a receiver/decoder by informing it that a particular software decoder should be invoked—perhaps some minutes before relevant data for a particular service will be transmitted so that the receiver/decoder can be fully ready for the data service when it becomes available. The latter code may be used by the RDS encoder to signal that incoming data to the encoder cannot be transmitted for some reason.

For each group type addressed by the application group type codes of a particular transmission, only one application may be identified as the current user of the channel. The AID code 0000 (Hex) may be used to indicate that the respective group type may be temporarily used for the normal features for which that group is already specified in the RDS standard. Application identification codes 0001 to FFFF (Hex) indicate applications registered in the ODA directory. These AIDs are allocated by the RDS registrations offices upon satisfactory receipt of a completed registration application form (as shown in

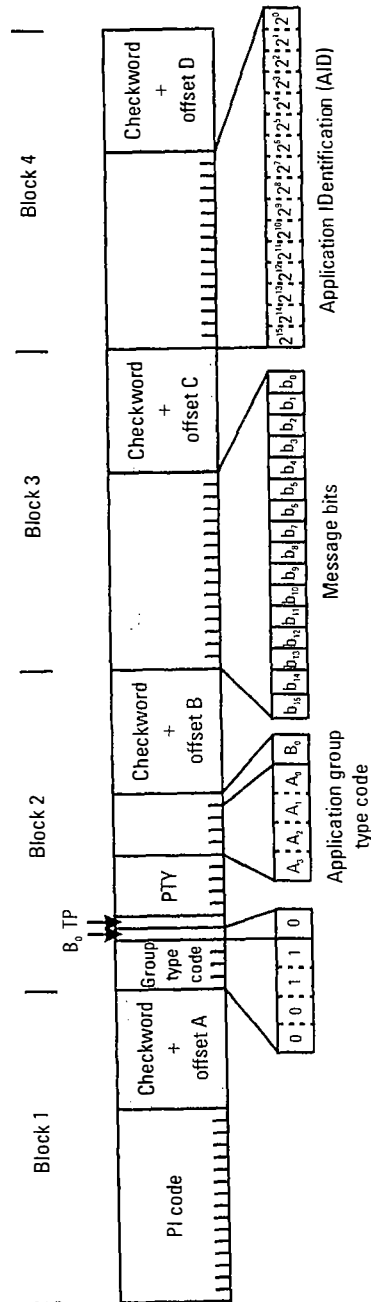


Figure 9.1 Bit map of type 3A group used for application group type code and AID. (Source: EBU.)

Figure 9.2). The registration office for Europe and the rest of the world, except North America, is at the EBU, Geneva, Switzerland. For North America, covering Canada, the United States, and Mexico, the registration office is situated at the NAB, Washington, DC.

The choice of group type for a particular transmission of a registered ODA will depend upon the other features used within the particular dynamic RDS multiplex. For example, if a transmission carries an in-house data stream in type 6A groups, then this group will not be available, so another group type should be chosen. But the *same* ODA may be conveyed in a *different* transmission using the type 6A group if it is not used for in-house data.

9.4 The Group Structure of Open Data Applications

Open Data Applications must use the data format shown in Figure 9.3 when using ODA type A groups and as shown in Figure 9.4 when using ODA type B groups.

Both type groups are available according to the data application needs. A large-capacity data service would use type A groups, which offer 37 bits per group, whereas a low-capacity service needing only 21 bits would possibly only need to use a type B group. For a very low data capacity service, there is a third option and that is to use no ODA groups, but just use the type 3A group, which has 16 message bits (see Figure 9.1).

Question	Information	Comment
Application name:		5 or 6 words, maximum
Application description:	Please use additional pages if desired	Give as much detail as possible
Open data mode: (see Table 9.2)		Choose one mode, only
ODA details, specifications and references:	Tick, if publication not permitted [] Please attach additional pages	Give all details, proprietary documents and references
Capacity requirement for both the ODA and AID groups:	Tick, if publication not permitted [] a) ODA groups/second b) type 3A groups/minute Please use additional pages if desired	Indicate: ODA groups/second and type 3A groups/minute. Describe any constraints

This Form will be published in full, except the last two answers, if specifically not permitted.

Figure 9.2 Part of the ODA registration form. (Source: EBU.)

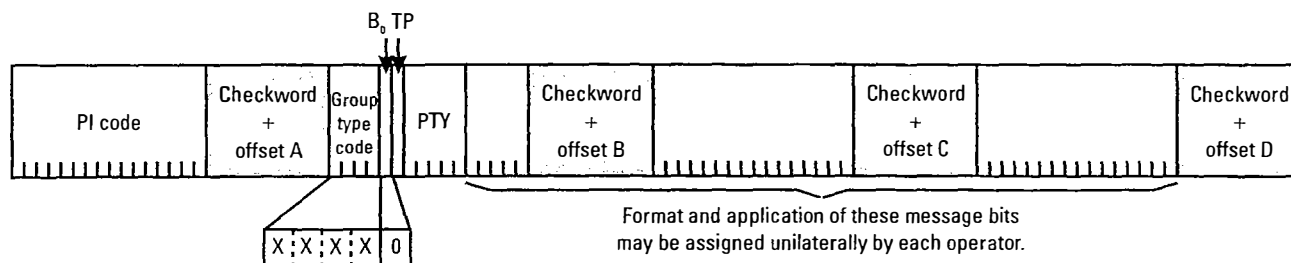


Figure 9.3 ODA type A groups, with 37 useable bits. (Source: EBU.)

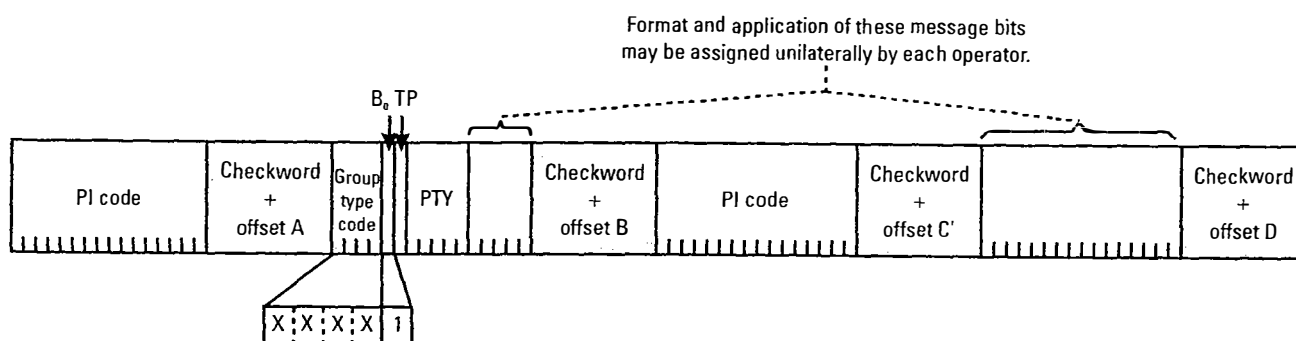


Figure 9.4 ODA type B groups, with 21 useable bits. (Source: EBU.)

9.5 Registration of an Open Data Application

There are no Open Data Applications explicitly specified in the RDS or RBDS standards. Instead, they are subject to a registration process. All registered applications are listed in the ODA directory, (published on the RDS Forum Web site (see Appendix K), which makes reference to appropriate companion standards and/or normative specifications. These specifications may either be public (i.e., specification in the public domain) or private (i.e., a proprietary specification not in the public domain). The terms “public” and “private” do not imply the degree of access to services provided by an application; for example, a public service may necessarily include encryption, so the details would not be made available in the public domain by the data service registrant.

The RDS standard provides for both situations, and a registrant may choose either situation without constraint. Part of the RDS Open Data Applications registration form is shown in Figure 9.2. Additionally, the form requires quite minimal information from a registrant to ensure that all ODAs are logged and basic parameters are known publicly. Generally, applications are confirmed quickly and easily by the RDS registrations office, which also gives advice on the requirements of new ODAs, in order to satisfy all the needs of the RDS specification. This approach allows completely new data services companies to develop new applications in a very economic way and to then be in a position to make the necessary commercial agreements with transmission operators anywhere they want to establish their services. To support this process, the RDS specification also carries a checklist that applicants must complete, together with their application, to help ensure that they have considered the best possible implementation—from the RDS perspective as well as from their service objective. This is particularly important to help preserve the very small RDS data capacity resource.

The checklist, shown in Figure 9.5, is particularly helpful in advising data service applicants (who will probably not also be RDS experts) to consider using other aspects of (all) RDS transmissions to support their service application. For example, they may realise that some form of frequency agility will be needed by receiver/decoders, and that they can probably use the AF feature already implemented by the transmission operator to achieve their requirement. On the other hand, they may not require the same network configuration as required by the transmission operator to provide service to an audio broadcaster, so they would then have to include an application specific regime to achieve the required performance. This may be achieved either in the ODA groups or perhaps by using the type 3A group message bits, since this information could be allowed to build over a longer period.

Question	Notes
Does the application behave correctly when not all RDS groups are received?	Necessary for mobile RDS applications
Does the application provide the means to identify the service provider?	
Does the application allow for future proofing, by upgrading?	
Does the application require sub-sets of associated applications?	Use of variant codes and/or other groups (eg clock-time)
Does the application include provision to reference other transmissions carrying the same service?	PI and AF
Does the application include an additional layer of error protection?	RDS already has considerable capability
Does the application include encryption?	
Does the application include data compression?	
Have you defined the capacity requirements for the application?	
Have you defined the capacity requirements for the AID under normal conditions?	
Is your application able to assume and lose the use of a group type?	
If so, have you defined the AID signaling when use of a channel is assumed?	
If so, have you defined the AID signaling when use of the channel ceases?	

Figure 9.5 Part of the ODA registration checklist. (Source: EBU.)

9.6 Guidelines for Using ODA

In order to further enhance the possibilities available to ODA designers, the RDS specification allows a full range of group type utilisations, as shown in Table 9.2. Normally, mode 1.1 or 1.2 will suffice, but it would be possible to mix group types if an application really required modes 2 or 3 to fully implement the required service. Clearly, these modes have an additional requirement by signalling through the use of *two* type 3A groups (using their application group type codes to fully describe the RDS datastream), that two ODA group types will be found in the service.

Table 9.2
ODA-Mode Options

Mode	Description
1.1	Type A groups, used alone
1.2	Type B groups, used alone
2	Type A groups and type B groups, used as alternatives
3	Type A groups and type B groups, used together

To ensure reliable data reception—for example, in the mobile reception conditions—it is recommended that data groups be repeated at least three times. The received blocks can then be compared bit-by-bit for acceptance, or if the message spans over several blocks or groups, one can use a two-byte cyclic redundancy to check in the last block for that whole message. If one byte in each group is reserved for message identification and as a counter, the groups could be mixed in any order and still be correctly decoded.

10

Differential GPS

10.1 Introduction

Using RDS for Differential Global Positioning Systems (DGPS) has become a reality in a large number of countries. However, although this issue has generated a relatively wide interest since the early 1990s—and implementation issues were widely discussed in both the RDS Forum and the U.S. National Radio Systems Committee—due to diverse commercial interests, no common standard has ever emerged. Ultimately, the new ODA feature was commonly identified as being most suitable to carry such a service.

This chapter describes the technological issues that need to be considered if one wants to implement DGPS within RDS. Such a decision would also have to take into account other alternative technologies that either achieve the same or even better results than those that one can now achieve with RDS. Internationally, continuous DGPS services that could, for example, serve European road users do not appear to be possible using RDS because of subscription and institutional challenges, which would require too much bandwidth to achieve satisfactory results.

In addition, one should also realise that whatever solution is adopted, it will probably only permit a relatively small market sector to be developed.

10.2 Positioning With GPS

The Global Positioning System is a worldwide satellite positioning/location system developed for military use by the U.S. Department of Defense (DoD).

It uses a network of 24 NAVSTAR satellites in nongeostationary orbits distributed over six planes; that is, with four satellites in each plane. The system was gradually built up and has become fully operational since 1995. It is currently U.S. government policy that GPS is also generally available for civil use and without any restriction to the international civilian user community. The technique is based on simultaneously measuring the distance from a GPS receiver up to at least four different GPS satellites. Due to various reasons, the distance measured to each satellite is not accurate. Nevertheless, GPS is able to deliver a standard positioning service that is limited to a $\pm 100\text{m}$ accuracy level. However, the operator of the GPS system can influence the limits of accuracy through the introduction of a deliberate error source, known as the selective availability. The selective availability may be switched on or off for military reasons, and when switched off, the accuracy is increased to $\pm 15\text{m}$ for civil use.

The satellites transmit coded information about time and their ephemeris (parameters that describe the orbits of the satellites). A GPS receiver (navigator) measures the propagation time of the signals transmitted and, with known signal propagation speed, the navigator converts the time to the distance between the navigator and each satellite (pseudo-range, PR), which then permits the calculation of its own latitude, longitude, altitude, course and speed (see Figure 10.1).

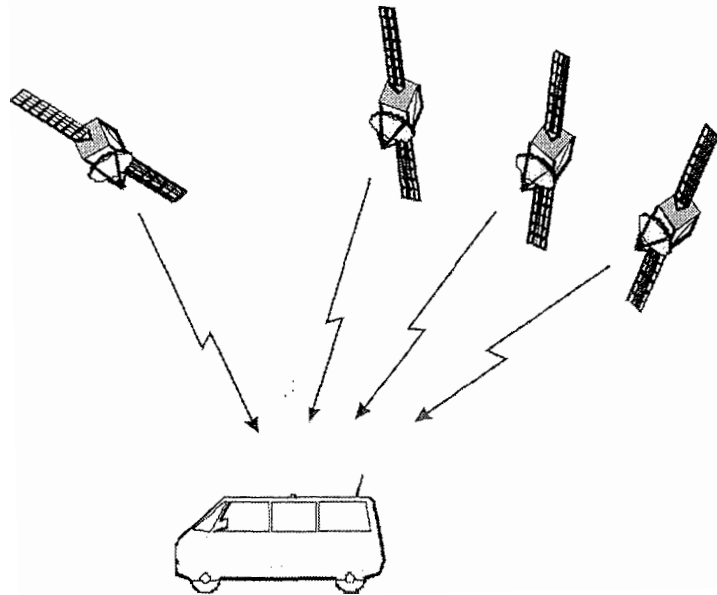


Figure 10.1 Principle of a satellite based positioning service. (Source: EBU.)

10.3 The Principle of Differential Correction

If there are two GPS receivers at different locations, each one registering identical signals, then the accuracy of the system can be augmented. For example, the baseline between the two receiving points can be computed with an accuracy of up to several millimetres when the data are combined for postprocessing. This technique is typically employed in surveying.

For use in real-time applications, a one-way data link is necessary between the two GPS receivers. Critical points are the data transmission rate and the distance between the two receivers. At low data rates (e.g., 100 bps), an accuracy of $\pm 1\text{--}5\text{m}$ is possible up to a distance of 1000 km between the receivers. At higher data rates (e.g., 2,400 bps), an accuracy of several centimetres is possible up to a distance of 10–20 km between the receivers (see Figure 10.2).

The low data rates offered by RDS on FM or AMDS on LF and MF radio are thus suitable only for DGPS applications that are limited to the $\pm 1\text{--}5\text{m}$ accuracy class. Higher accuracy applications require higher data rates and must therefore make use of DARC, DAB, or other telecommunication media.

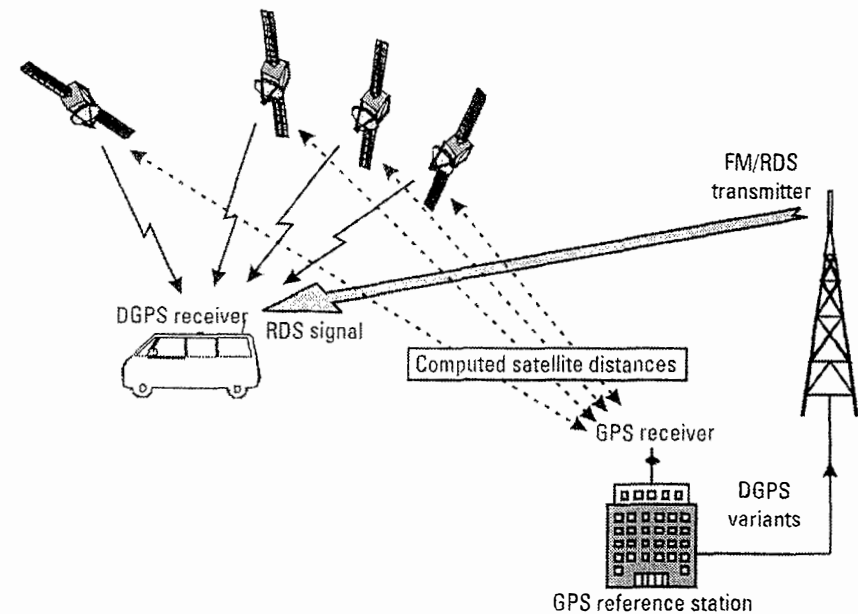


Figure 10.2 Principle of a DGPS positioning service using RDS. (Source: AZTEC.)

10.4 The RTCM DGPS Correction Format

10.4.1 Introduction

In 1983, the U.S. Institute of Navigation asked the Radio Technical Commission for Maritime Services (RTCM) to develop recommendations for transmitting differential corrections to users of GPS. A special committee, No. 104, was established, and it published version 2.0 of the RTCM Correction Format in 1990. A further developed version—version 2.1—was published in 1994 [1]; it contains additional formats that support real-time kinematic applications. RTCM version 2.1 provides 63 different message types, of which 26 were defined. Some of them are still tentative or reserved, while eight of the message types are fixed (see Table 10.1). Each type starts with a header, and the technical information is then allocated to a variable number of 30-bit words.

The RTCM SC-104 DGPS format is widely used by GPS manufacturers, and a significant effort was made in deriving that format. However, the issues dealt with by the RTCM committee are somewhat different than those that must be addressed when a data channel with relatively limited data transmission capacity such as RDS is used. The underlying principles are, of course, the same, and the RTCM format can therefore be used as a guideline to determine, for example, the RDS-ODA format to be used for implementing DGPS within an RDS data stream.

The RTCM format itself is unsuitable for RDS due to its excessive bandwidth. Therefore, the correction elements required will have to be compressed for transmission via the RDS data channel. The RTCM format then needs to

Table 10.1
Defined RTCM Message Types

Type	Function
1	Differential GPS corrections
2	Delta differential GPS corrections
3	Reference station parameters
5	Constellation health
6	Null frame
7	Beacon almanacs
9	Partial satellite set differential corrections
16	Special message

be reconstructed within a special service-provider-specific DGPS RDS FM subcarrier receiver before the correction data is delivered to the navigator. For example, to achieve a $\pm 5\text{m}$ accuracy, 20 to 50 bps within RDS-ODA to carry the correction data will be sufficient. Remember, as explained in Chapter 9, one ODA group type A (e.g., type 11A group) can carry 37 bits for the application under consideration.

10.4.2 Required Data Elements

Differential GPS requires that certain types of information be available to the DGPS navigator [2]. In the following, some of the most important elements commonly used by DGPS service providers and based on RTCM formats are briefly explained.

10.4.2.1 Pseudo-Range Correction (PRC)

The pseudo-range correction is the most fundamental data item needed by the navigator. It describes the correction for a satellite that should be applied at a certain point of time (the time at which the pseudo-range measurements were made at the reference station). The PRCs are strictly only valid for the epoch when they are computed at the reference station. When the PRC is transmitted to a mobile user, time goes by, and the values grow older and deviate more and more from the actual value. To overcome this, a reference station makes a prediction about the rate of change of the PRC, which is called the range rate correction (RRC).

10.4.2.2 Range Rate Correction (RRC)

The RRC is used by the navigators to propagate the PRC forward to the point in time at which it can be applied by the navigator. Since the PRC was generated at a time in the past and a variable time was required for it to be transmitted and received by the navigators, the rate term provides the means for the correction to be made current at the navigator.

The composite PRC computed by the navigators from the PRC and RRC terms is in error to the extent that unmodelled effects cause the actual pseudo-range correction to differ from the computed pseudo-range correction. The most significant source of error is selective availability.

10.4.2.3 Age of Correction Data: Time of Correction with the Modified Z-Count

The correction PRC and correction rate RRC for a satellite are useless unless the times for which they were computed are also conveyed to the navigators.

In RTCM, the list of PRCs and RRCs for all satellites is therefore connected with the epoch of their creation, called "modified z-count," which counts the seconds of the current hour. A user DGPS receiver calculates the pseudo-ranges for the epoch in which it can use them. The predicted and broadcast values of RRC grow worse the older they are, such that accuracy degrades significantly with values older than 20–25 seconds.

10.4.2.4 Satellite Identification (SATID)

The correction information for each satellite is different, and there is no assurance that corrections are received by all navigators. Therefore, it is necessary to identify the satellite whose corrections are being transmitted.

10.4.2.5 Ephemeris Parameters

The ephemeris is a set of parameters that describe the orbits of the satellites. The ephemeris information for each satellite is changed periodically (approximately every one to two hours). The DGPS correction information is based on a particular ephemeris, available to the reference station when the correction is generated. It is necessary to advise the navigators of the ephemeris in use at the reference station when the corrections were computed, because the corrections may be properly used by the navigator only if the same ephemeris is employed.

The issue of data ephemeris (IODE) is the key that ensures that the user equipment calculations and the reference station corrections are based on the same set of orbital and clock parameters.

10.4.2.6 User Differential Range Error (UDRE)

It is important for the reference station to advise the navigators of the validity and approximate error in the differential corrections. This information permits the navigators to decide whether or not to use the correction from a particular satellite and how the satellite may be weighted in the position computation.

10.4.2.7 Reference Station Location Data: Station ID and XYZ Coordinates

In general, it is useful for the navigators to know the location of the reference station. This permits the navigators to use ionospheric and tropospheric models to estimate the amount of error in the pseudo-range measurements made at both the reference station and the navigator.

This cannot be done at the reference station since the navigator locations are unknown to the reference station and there is no consistent model available for either troposphere or ionosphere that is accepted by all GPS manufacturers. For this reason, no ionospheric or tropospheric models are used at the reference station.

In the RDS case, it is assumed that the reference station is relatively close to the FM transmitter. The limited range of most FM stations (about 100 km) implies that the navigators will not be far from the transmitter. Hence, a user close enough to receive the FM station will generally be well within the range at which the differential corrections are accurate. These arguments indicate that there may not be a strong need for the navigators to know the location of the reference station.

However, the reference station altitude may be useful, because the atmospheric models that are commonly used require the altitude of both the reference station and the navigator. The tendency to site FM transmitters at relatively high locations to improve signal coverage tends to increase the need for reference station altitude.

10.4.2.8 Service Quality Parameter: SQ/Station Health

This DGPS format offers positioning service providers the possibility for services with different accuracies, depending on the frequency at which corrections are supplied. An indication in the messages is given to advise navigators of the expected accuracy of the service. The service quality parameter, Station Health provides this capability.

10.5 How RDS can be Used for Differential GPS

10.5.1 Design Considerations

For an average number of satellites, the type 1 RTCM message (the most important and most frequently transmitted message) is 500 to 700 bits long (e.g., 680 bits for nine satellites) and is split into independent parts. For a DGPS service within RDS, this data has to be rearranged so that the data concerning each individual satellite requires only 37 bits and can therefore be conveyed in one RDS group. Additional overhead information, which is necessary to reconstruct the exact RTCM message, is required only a few times per minute.

This rearrangement of the satellite data guarantees a stabilised evaluation of the data. As already noted, to transmit the original RTCM format takes a long time. By creating self-sufficient or autonomous groups, only the information relating to one satellite can be affected by transmission errors such as those caused by multipath propagation—the rest of the data remains undisturbed.

PRCs are not transmitted with their actual value, but are related to the last integer minute by means of the RRC. The mobile station has to reconstruct

the current value of the PRC by using its own clock. Thus, the frequent transmission of the z-count can be avoided and the PRCs become nearly independent of any overhead information. The data for nine satellites need $9 \times 37 = 333$ bits, instead of the 680 bits needed by the original RTCM correction format.

When the RDS-ODA data format is used to transmit DGPS information, the AID and application group type code will be transmitted relatively infrequently in type 3A groups (i.e., once per minute). The DGPS correction data will then be mapped into the 37 available bits of the application group type (e.g., the type 11A group). Figure 10.3 [3] shows an example of how this is done in principle, that is taken from the German RASANT system [4]. To be able to determine the size for the RTCM data elements described above, it is necessary to decide how many bits will be required to map the information into the RDS-ODA application group. This decision implies that some kind of reduction for the RTCM data elements will be used that takes into account the available data transmission rate (limited in a practical implementation to only one or two RDS-ODA application groups per second) and the few corresponding bits thus available in these groups.

Each service provider has to decide this data format specifically for the service to be provided. Therefore, the DGPS RDS decoder that the end user wishes to use will always be specific to the particular service provider in spite of the fact that the GPS navigator uses standardised RTCM-formatted DGPS correction data. The DGPS RDS special receiver thus has to supply the correction data as input to the GPS navigator in the format of the RTCM standard.

Neither the RDS standard nor the RBDS standard contains an open standard for implementing DGPS. This is due to the fact that at the time when the RDS-ODA specifications were drawn up within the RDS Forum in 1995, DGPS using RDS as a data transport mechanism was already implemented in several countries—or at least at a very advanced state of system design. Several service providers were competing with similar but different proprietary data formats and advocating open and encrypted DGPS services. Because of this, no agreement was reached to include an open DGPS standard into the RDS/RBDS standards, both under revision at that time for the purpose of upgrading. All that could be achieved was that there was general agreement that RDS-ODA would provide a suitable means to achieve DGPS implementation within RDS.

10.5.2 Service Examples

10.5.2.1 RASANT in Germany

In May 1995, the Working Committee of the Surveying and Mapping Authorities of the Federal Republic of Germany decided to introduce a real-

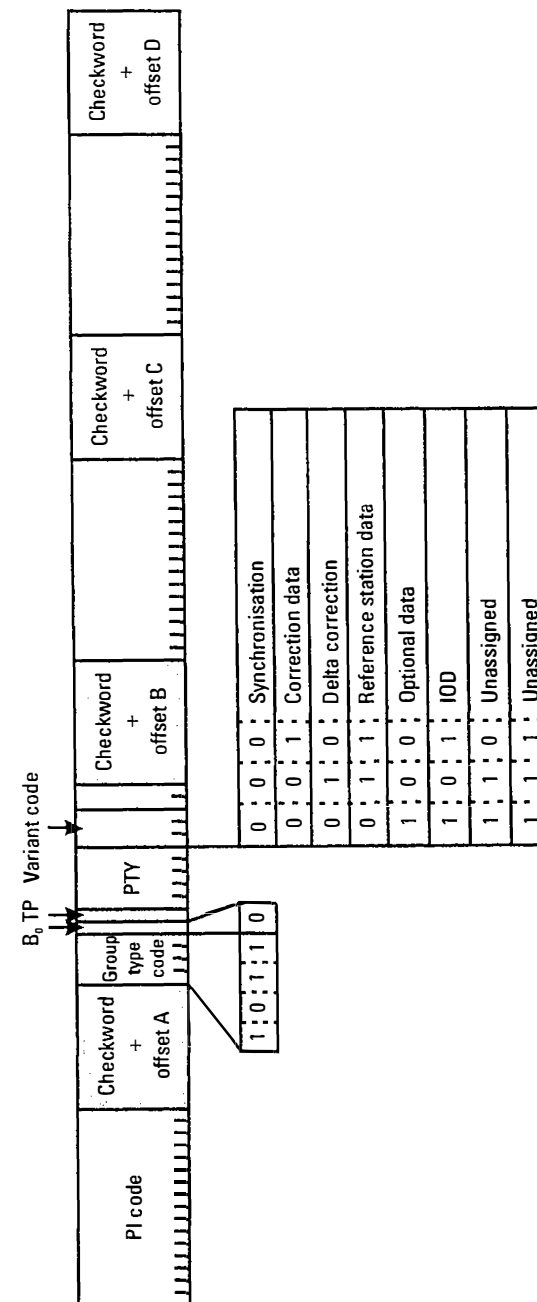


Figure 10.3 Example for using variant codes in block 2 to map 34 bits of DGPS data into group type 11A, blocks 2 (2 bits), 3 (16 bits), and 4 (16 bits). (Source: EBU.)

time DGPS service throughout the country. Radio Aided Satellite Navigation Technique (RASANT), which has been developed by the Westdeutscher Rundfunk (WDR) and the Landesvermessungsamt Nordrhein-Westfalen (the surveying and mapping agency of Northrhine Westfalia), uses RDS-ODA as the additional data channel. The service will be available from 1998 as an open service, and it will be financed by a one-time fee paid by the user, which is included in the price of the RASANT decoders available from several suppliers in Germany.

The RASANT technique can process and transmit the complete variety of RTCM messages via RDS. However, due to the low data rate of the present RDS service, RTCM message types 1, 2, 3, 5, 9, and 16 are modified and conveyed in an appropriate DGPS format, called DGPS variants.

Nearly all types of GPS receivers with DGPS capability can add these PRCs to their own pseudo-ranges and improve the positional accuracy from 100m down to between 1 and 3m. For the proven accuracy level of $\pm 1-3$ m, an RDS capacity of one group per second is sufficient. In this case, the main DGPS variants, as shown in Figure 10.3, are supported. More capacity is required if additional variants are used (e.g., the alternative frequencies of the transmitters that carry a RASANT service).

10.5.2.2 EPOS in Sweden

Teracom, the Swedish transmission operator of the four national FM radio networks, introduced a DGPS service called EPOS at the end of 1994. EPOS is available as a basic service with a ± 10 m accuracy and as a premium service offering an impressive ± 2 m accuracy—both claimed with 95% confidence. The differential corrections for the GPS system are made available via the RDS channel all over Sweden through a renewable annual customer subscription and using modified RDS receivers (an EPOS receiver) purchased by the customers.

There are 12 EPOS service GPS reference stations, co-located with some of the Swedish land survey sites throughout Sweden to generate local differential corrections. These are first preprocessed and then all forwarded to a central concentrator and RDS network server situated at the operations centre (OPC) for the entire national radio and TV services located in Stockholm.

A multidrop network then redistributes the real-time stream of differential corrections to the matching local FM transmitter sites throughout Sweden. At each transmitter site, the corrections are inserted into RDS type 11A groups. There is a very short delay—less than one second—between the calculation of the differential corrections at the various reference stations and their reception by the EPOS receiver. Integrity monitoring and backup functions for the

EPOS service are all incorporated in the system, and they are also supervised and operated by OPC.

The commercial service is much more than just the technical infrastructure described. Considerable effort was therefore invested in the design and implementation of a custom-made subscriber management system for the handling of customer subscriptions and other administrative functions. Gateways to Teracom's existing customer and invoicing routines were also established. The new data system even allows the customer—in addition to Teracom—to address and initiate his or her own EPOS receiver via the FM RDS network for the purchased service accuracy and subscription duration once the invoice has been paid. Distribution and sales of the EPOS service and the associated choice of receivers will be accomplished through cooperation with existing wholesale and retail outlets already selling GPS equipment.

10.6 Other Alternatives

10.6.1 Maritime Radio Beacons

The International Association of Lighthouse Authorities (IALA) has drawn up a frequency plan for maritime radio beacons to broadcast DGPS data. Implementations of this type already exist in several European countries where some 50 beacons are planned, with most of them operational since 1994/95 and broadcasting DGPS data with a bit rate of 200 bps. The coverage range of these transmitters is on the order of 200 km. The accuracy achieved is claimed to be between ± 1 m and ± 5 m.

10.6.2 AMDS

Since 1994, AMDS has been used in Germany on LF and MF, mainly on transmitters from DeutschlandRadio/DLF. AMDS uses a data rate of 200 bps, of which two-thirds is used to distribute DGPS data. The same service is also being tested in field trials conducted in Norway, the Netherlands, and Switzerland. Encoders and decoders are exclusively available from Bosch/Blaupunkt in Germany. Implementation expertise is available from Technische Universität Dresden, where the technology used was developed. The accuracy achieved is ± 1 m to ± 5 m. The coverage areas are very large. For example, the LF transmitter at Donebach uses 153 kHz and covers all of Germany, and Beromünster uses 207 kHz to cover all of Switzerland.

10.6.3 DARC

The relatively high net data rate of 9 kbps achieved with the LMSK-modulated DARC subcarrier on 76 kHz within an FM multiplex signal allows the provision of advanced GPS services, which may include a DGPS service with a high update rate and phase measurements that permit an accuracy of better than 10 cm. This was demonstrated during 1996/97 field trials in Austria involving the national broadcaster ORF. Similar tests, to be carried out in Norway, are also planned.[5].

10.7 GLONASS: the Alternative to GPS

Since 1996, the Russian Federation has been operating a system similar to GPS, called GLONASS. That system is also available for civilian use, but receivers are not yet as commonly available as for GPS. They use a different communication protocol. The accuracy without differential correction is around $\pm 10\text{m}$.

10.8 EGNOS: the European Component of GNSS

The Global Navigation Satellite System (GNSS) is an action plan launched by the European Commission. This plan has two phases [6, 7]:

1. GNSS-1 aims at implementing the European component, European Geostationary Navigation Overlay Service (EGNOS), which will use the U.S. GPS and Russian GLONASS signals with an augmentation (differential GNSS) of their integrity and accuracy by an additional ground- and space-based infrastructure scheduled to be in operation from the year 2000. This project is jointly pursued by the European Commission, the European Space Agency (ESA), and the European civil aviation control agency Eurocontrol.
2. GNSS-2 is envisaged as a new civil worldwide navigation system that will be internationally controlled and managed, and could be a successor of the existing military systems.

References

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- [2] Galyean, P., NRSC/RBDS DGPS Working Group—Status report of the coordinator, Torrance, CA, June 3, 1994, Working document of the RDS Forum, 1994.
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- [4] Raven, P., S. Sandmann, and G. Schoemackers, "RASANT Radio Aided Satellite Navigation Technique," *EBU Review-Technical*, No. 267, Spring 1996, pp. 27–31.
- [5] Second SWIFT Forum, Lulea, Sweden, Published by Teracom Sweden, 1997.
- [6] Global Navigation Satellite System, A brochure published in 1997 by the European GNSS Office at the European Commission (DG VII-A2) in Brussels, Belgium.
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11

RDS Encoder Communication Protocols and the UECP

11.1 Introduction

This chapter explains the need for a communication protocol to be used between broadcaster (studios) or data service provider and RDS encoders. The EBU has developed a standard for this protocol that is commonly called the Universal Encoder Communication Protocol (UECP). It is especially recommended for use when RDS is implemented within a network of several transmitters and also when data needs to be assembled from various data service providers. The concept and the data format of this protocol are also described in some detail.

11.2 Why RDS Encoders Need a Communication Protocol

Transmission operators who want to implement an RDS service need to install RDS encoders. They are normally installed at transmitter sites adjacent to the stereo encoder, which generates a 19 kHz signal that the RDS encoder uses to synchronise its output RDS data stream.

Two “types” of RDS can be provided: Static RDS services can be provided by an RDS encoder simply providing RDS information, such as a fixed AF list, from internal memory; whereas dynamic RDS services, such as Radio-Text, require data input to an RDS encoder. Even static RDS services may have

to be changed from time to time, depending upon the network configuration and the type of radio programme on air.

Dynamic RDS is needed for a number of reasons. RDS data related to the radio programme content (see Chapters 3, 4, and 6) requires a high degree of control from the on-air studio. In the case of a data service such as TMC, an operator-specific implementation under ODA, or Radio Paging (see Chapters 7–9), a high degree of control is required from the service provider to supply their data to the RDS encoder—either to a single broadcast transmitter or to a network of broadcast transmitters.

Simple but numerous different commands from the on-air studio or the service provider have to be sent, via a suitable data link, to the RDS encoder. For example, the on-air studio could change the status of the TP, TA, and MS flags to reflect the programme status. Such commands are often derived from “automated” functions to avoid operator intervention. A single-service broadcaster could possibly use a dedicated audio mixer channel for announcements, so that the MS flag is set to the “speech” condition every time the fader is opened, by using “back” contacts to send a command via the data link.

Once a dynamic RDS encoder has been chosen, then in most situations, a unidirectional data link is only possible for update data to be sent to the RDS encoder. This is due to the fact that for economic reasons, the transmitter operator had to adapt existing analogue, or even digital, audio distribution networks, which are essentially unidirectional, to add a data distribution function.

One possibility for implementing a unidirectional data link within an existing audio distribution network is using a subcarrier just above 15 kHz (nominally the highest audio frequency used in FM broadcasting), and using the fact that the audio channel is often designed for a 20 kHz bandwidth. A system of this kind is the AUDIODAT system, which was developed in Germany by ARD/SWF. This system has a bit rate of 200 bps. Communication codec equipment for this system is available from RE Technology and Rohde & Schwarz. This allows the audio and data signals to be combined at the studio, carried on the wideband audio circuit and extracted at the transmitter site, and for the audio to be connected to the stereo encoder and the data to be connected to the RDS encoder.

A number of proprietary update protocols were implemented on data links between source servers and the RDS encoders; several of them were encoder manufacturer specific. These protocols were used to send data messages from an RDS controller/management system (or simply an RDS encoder server) to the RDS encoders. Acknowledgements from the encoder were not essential; instead, it was arranged to send repeats of each message in order to ensure their receipt. In this way, a whole range of dynamic RDS features could be used by the broadcaster to enhance RDS performance for the listener. In

some cases, an RDS encoder controller, running on a PC, has been used to send update messages to the RDS encoder. If a very full implementation is required, a dedicated RDS management computer system, frequently called an RDS server, has to be used to control on a scheduled basis the whole range of RDS features, including the radio programme-related data such as TP, TA, PTY, RT, and the full array of EON references.

11.3 Why the EBU and Encoder Manufacturers Developed the UECP

In the early 1990s, the EBU studied a requirement that the various existing and implemented RDS encoder communication protocols be harmonised. Such harmonisation would then enable broadcasters to purchase RDS system components (e.g., RDS encoders, RDS server computers, and software) from a variety of sources. This would permit significant economies in network operation, and it would offer the necessary high flexibility to implement in successive stages enhancements to already existing RDS implementations (specifically, within transmitter networks). RDS system component manufacturers would then also be able to integrate their products with those from other manufacturers, enabling more complex systems to be produced than those that would otherwise have been possible.

These proprietary update protocols had similar functional elements; however, they differed significantly in their environmental models. The structure, functionality, and addressing of their intended networks and the data structures within each RDS encoder are often quite different. Therefore, the Universal Encoder Communication Protocol (UECP) specification, now widely accepted [1], was based on *harmonised* environmental and encoder models.

The UECP is a layered communication protocol that is in line with the commonly used OSI reference model (ISO Recommendation 7498). The UECP in its present version—version 5.1 (August 1997)—encompasses all current RDS features, including the latest TMC specifications [2]. It is also designed to accommodate all new developments that will use the open data applications (ODA) concept (see Chapter 9).

The model and protocol also provide a template specification upon which new products may be based and, most specifically, it permits other existing encoder communication protocols to be enhanced. Thus, many existing devices can be adapted to meet the present functionality required. However, it is strongly recommended that all new RDS encoders should permit communications to also be operated under the UECP protocol (version 5.1 or later). The

specification can now be freely obtained from the EBU by downloading it from the RDS Forum Web site (see Appendix K).

Organisations and manufacturers that have contributed within the EBU (and later within the RDS Forum) to the elaboration of the UECP specification, including AZTEC (see Figure 11.1), Auditem, BBC, Deutsche Telekom, Ericsson (formerly Teli), RE Technology, Rohde & Schwarz, TDF, Telefunken Sendertechnik, and Teleray. However, attention is drawn to the fact that at the end of 1997, only a few RDS encoder manufacturers had implemented UECP version 5.1. This version is specifically needed for TMC and ODA implementation.

11.4 The UECP Concept

11.4.1 Addressing Method

Communication to RDS encoders needs to be capable of many levels of addressing:

- To all encoders;
- To specific sets of encoders or to a particular device.

This may be accomplished by unique physical connections or, even better, by a suitable logical addressing method.

In defining an environmental model for the UECP, the following assumptions were made:

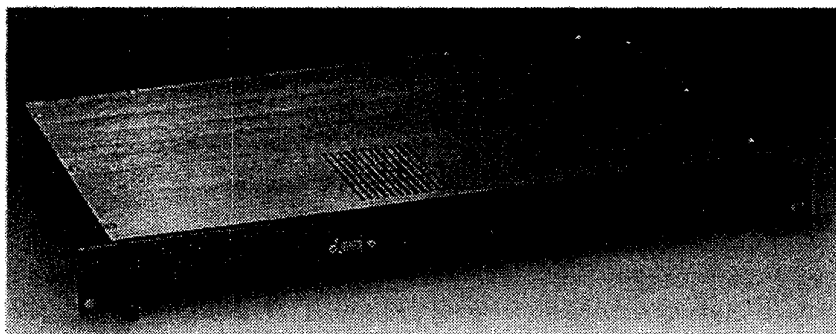


Figure 11.1 First RDS encoder implementation of UECP version 5.1: the AZTEC RADIOMEDIA FMX 440 Digiplexer (RDS and DARC). (Source: EBU.)

- The data stream will feed one or more transmitter sites. Each site will have a unique address, known as the *site address* (a number in the range 1–1,023). All encoders at a particular transmitter site share the same site address.
- An encoder will possess one or more site addresses. One of these must be unique to the particular physical site location. Additional site addresses are permitted for a particular area, region, or country.

To clarify this concept, an example is given. All encoders at the NEWTOWN site have the unique site address “123.” Other encoders in the system are not permitted to use this address. Encoders at the NEWTOWN site also have the site address “267,” which is allocated to all encoders in the LAKEVALLEY area. Messages arriving at the NEWTOWN site with either of these two site addresses will be accepted. Messages arriving at the LITTLEVILLAGE site (address “452”), also in the LAKEVALLEY area, will not be accepted if they carry the NEWTOWN site address, but will be accepted if they carry either the LITTLEVILLAGE or the LAKEVALLEY site address. This example describes the first level of the addressing system (see Figure 11.2).

A second level of addressing is now introduced, the *encoder address* (a number in a range 1-63). Several RDS encoders are installed at each transmitter site, serving a number of programme services. Backup equipment is sometimes provided, sometimes not. A single backup encoder may even be provided for several programme services. Whatever the situation may be, each encoder at the site needs to be individually addressable.

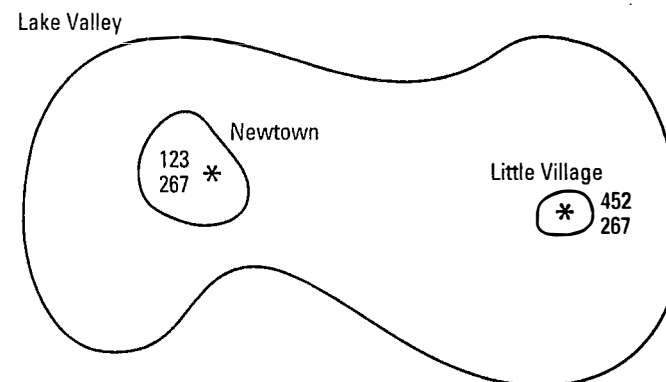


Figure 11.2 Fictitious example of site addressing with the UECP. (Source: EBU.)

An encoder will possess one or more encoder addresses. One must be unique to the encoder at that site. Additional encoder addresses may be assigned according to the encoder's usage or manufacture. However, the site and encoder addresses are not intended to specify a particular radio service. The specification of a particular radio service, a third level of addressing, is accomplished by using a *programme service number*. The site and encoder addresses should be thought of as being entirely physical, and are used only to address a certain "box" at a certain location. The functionality of the box is irrelevant in this context.

It is expected that many messages will be sent to all RDS encoders. Thus, the *global* number of zero (0) is defined for both the site and encoder addresses. Messages bearing the global site address are deemed to be acceptable at all sites in the system. Messages bearing the global encoder address are deemed to be acceptable at all RDS encoders at sites specified by the accompanying site address.

An RDS encoder will have two address lists, one of acceptable site addresses and the other of acceptable RDS encoder addresses. The site address list includes 0 (the global site address), the unique site address, and any additional site group addresses.

The RDS encoder address list includes 0 (the global encoder address), the unique encoder address, and any additional encoder group addresses.

A message is acceptable to a particular RDS encoder only if the site address is contained within its site address list and the RDS encoder address is contained within its RDS encoder address list.

11.4.2 RDS Encoder Conceptual Model

11.4.2.1 Software Model

Messages are accepted by the RDS encoder in accordance with the addressing method described above. Applicability is further determined by optional fields within the message itself (see Figure 11.3). This permits addressing of the following structures within an RDS encoder:

- *Data sets:* An encoder will have one or more data sets, each of which results in a particular RDS output. Each data set may refer to many programme services using the RDS EON feature. Only one data set is responsible at any one time for the encoder's output, and is known as the current data set. Data sets are addressed by the protocol as described below.

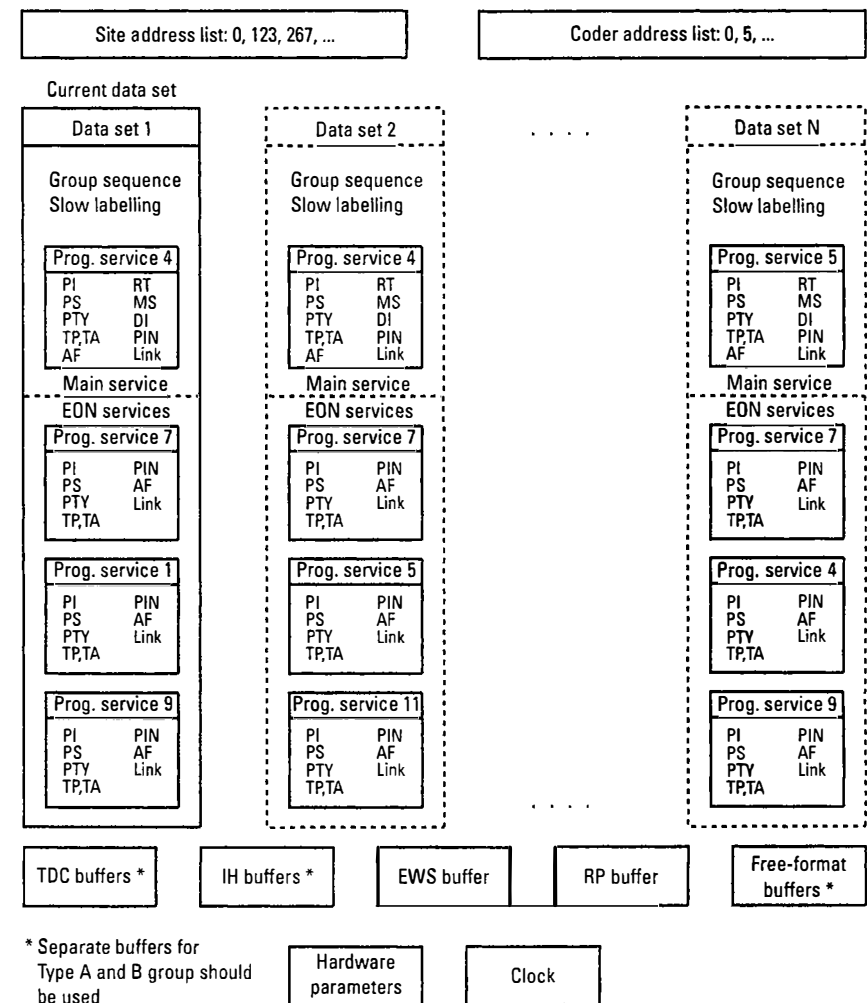


Figure 11.3 RDS UECP encoder software model. (Source: EBU.)

- *Programme services:* All programme services are identified by a unique *programme service number*, which is used to label data within RDS networks. In a network providing the EON feature, data for several programme services will be sent to an encoder, which may then identify that the data refers to one or more of the data sets and elements within the data sets used by that encoder. Programme services are addressed

by the protocol as described below. There is a specific memory area in each data set for each programme service.

- *Buffers:* Some information is buffered, for example EWS, IH, ODA, RT, TDC, TMC and free format groups. This means that the received information is placed in a queue awaiting transmission. It is possible to configure a buffer for cyclic transmission.

11.4.2.2 Hardware Model

A simplified model of an RDS encoder has been used in the development of the UECP (see Figure 11.4). The model does not include such obvious or necessary components as a power supply or a control panel, but includes only the blocks necessary to understand and develop the protocol itself. These are as follows:

- *Processor:* The central processing unit of the encoder, usually a micro-processor, with access to input and output devices, the real-time clock, and memory.
- *Memory:* Comprises ROM and RAM necessary for the operating software of the encoder, and appropriate RAM and ROM for stored data.
- *Real time clock:* Maintains the current time of day and calendar date. Used to generate type 4A groups (CT).
- *Serial communication interface:* Data, according to the UECP, is received and transmitted using the serial communications interface.

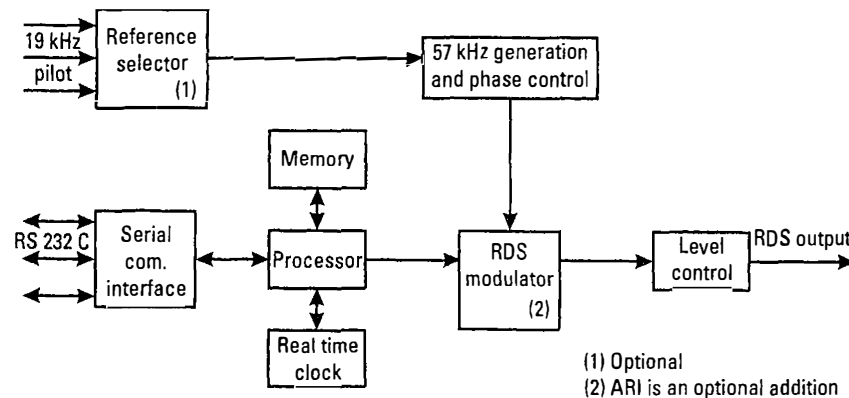


Figure 11.4 RDS UECP encoder hardware model. (Source: EBU.)

- *RDS modulator:* Produces the RDS biphasic signal, and optionally ARI in accordance with the CENELEC EN 50067:1998.
- *57 kHz oscillator:* Frequency and phase locked to the third harmonic of the selected 19 kHz pilot-tone reference source.
- *Reference selector (optional):* Selects one source of a 19 kHz reference signal, out of a maximum of six, to lock to the internal 57 kHz oscillator.
- *Level and phase control:* The level and phase of the RDS signal (optionally ARI) may be adjusted by the processor under the appropriate commands.

11.4.3 UECP Transmission Modes

The UECP is designed to operate in various communication modes as follows:

- *Unidirectional mode:* This mode is used on one-way communication links. Data is transmitted to one, a group, or all RDS encoders. Answer back is not required.
- *Bidirectional mode, requested response:* This mode uses a two-way communication link to transmit data to one, a group, or all RDS encoders. It enables the server to request data, status, and error reports from RDS encoders.
- *Bidirectional mode, spontaneous response:* A two-way communication link enables a server to transmit data to RDS encoders and request data from RDS encoders. RDS encoders are also able to spontaneously generate status and error messages.

11.4.4 UECP Protocol Description

At the physical level, it is necessary for the UECP specification to ensure electrical and mechanical compatibility of equipment. Interfacing to the RDS encoder is accomplished with a serial interface based on the well-known standard EIA RS 232C (compatible with V24/V28). This is a full-duplex interface with hardware handshaking, able to operate with modems.

The data is transmitted byte-by-byte in asynchronous mode. Transmission speeds can be set at the standard values between 75 and 115,200 bps.

Update data comprise a stream of data frames. A frame comprises a series of bytes, delimited by two reserved bytes, FE hex and FF hex, which mark the beginning and end of the frame. Each frame contains a destination address,

defining the set of RDS encoders to which the record is being sent. A sequence counter labels each separate record. The message itself is preceded by a byte, defining the message length, and after the message there may be a maximum of 255 bytes, followed by a CRC check word of two bytes.

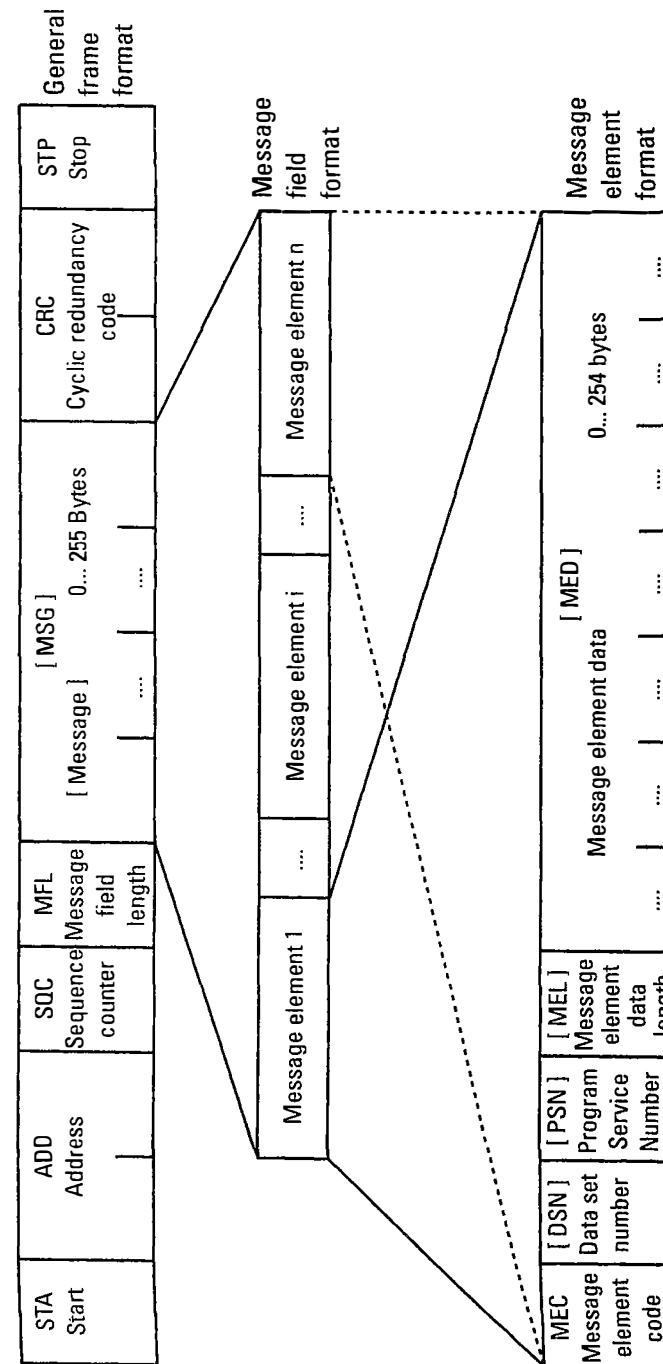
The start and stop bytes, FE hex and FF hex, are uniquely defined and may not occur in any other fields of a frame. In order to prevent this, a frame is byte-stuffed prior to transmission. The technique of byte-stuffing allows a byte-oriented protocol such as this to preserve certain unique values for framing purposes, and yet allows conveyed messages to utilise the full byte range (00–FF hex). This is achieved by trapping reserved bytes in illegal fields and transforming them into legal byte pairs. Byte values FD hex, FE hex, and FF hex are trapped in the fields “Address” to “Cyclic Redundancy Check,” inclusive, and transformed into a pair of bytes; that is, FD hex is transformed into FD00 hex, FE into FD01, and FF into FD02. Thus, the reserved bytes (FE and FF) will never occur within these fields in a transmitted record, and will only occur within the start and stop fields. When a message is received, the reverse technique is used to transform two-byte sequences (always starting with FD hex) into single bytes prior to the record being processed.

In cases where reserved byte values are present in the message, the transmitted message length will be increased. However, the length of a message is always defined in its unstuffed and shortest state.

Frames are built according to the structure shown in Table 11.1 and Figure 11.5, and then byte-stuffed prior to transmission. The check field consists of two bytes (prior to byte-stuffing), which represent the result of a 16-bit cyclic redundancy check (CRC) calculation. The divisor polynomial used to generate the CRC is the CCITT polynomial, $x^{16} + x^{12} + x^5 + 1$.

Table 11.1
Components of Each UECP Data Frame

Field Description	Descriptor	Field Length
Start	STA	1 byte
Address	ADD	2 bytes
Sequence counter	SQC	1 byte
Message field length	MFL	1 byte
[Message]	[MSG]	0...255 bytes
Cyclic redundancy check	CRC	2 bytes
Stop	STP	1 byte



[] Fields in brackets are optional. Inclusion is inherently defined by the Message Element Code

Figure 11.5 UECP Data protocol format consisting of a stream of bytes. (Source: EBU.)

The message field, if nonzero in length, consists of one or more message elements. Each message element has the structure shown in Table 11.2.

Several message elements may be packed together into one message field, subject to a maximum message field length of 255 bytes. An individual message element must not be split between different message fields.

The complete message field may be represented as follows:

MEC,[DSN],[PSN],[MEL],[MED],[[MEC,[DSN],[PSN],[MEL],[MED]],...

Fields and whole message elements shown in square brackets are optional. Message elements may be concatenated freely, subject to a maximum message field length of 255 bytes.

The data set number (DSN) permits a message to be targeted to the following within an encoder:

- A specific data set;
- The current data set;
- All data sets.

The PSN permits a message element to operate a number of services within one or more data sets.

Message element data consists of one byte describing the length (number of bytes that follow as data) and the data, which are all coded as bytes. Different classes of message are defined, such as RDS message commands, Open Data Application commands, transparent data commands, paging commands, clock setting and control commands, and remote and configuration commands

Table 11.2
Format of Each Message Element

Field Description	Descriptor	Field Length
Message element code	MEC	1 byte
[Data set number]	[DSN]	0...1 byte
[Programme service number]	[PSN]	0...1 byte
[Message element data length]	[MEL]	0...1 byte
[Message element data]	[MED]	0...254 bytes

(RDS adjustment and control, ARI adjustment and control, control and setup commands, bidirectional commands, and specific message commands).

Remote and configuration commands make it possible to control the various functionality options of RDS encoders, or permit request messages to be given from the RDS encoders in the case of a bidirectional transmission mode.

RDS message commands (for more details, see Appendix L) make it possible to communicate all the RDS features that have to be processed by an RDS encoder.

The data is transmitted to the RDS encoder using the specified command structure and stored in memory according to the encoder software model. The RDS encoder must also be told about the types of groups to be transmitted and about the appropriate transmission rate for every transmitted group type. This is achieved with the group sequence command, which is treated by the encoder like a group enable command. When a specific group is encountered in the sequence, data relating to that type is transmitted, if available. If no data for a specific group type is received, then the group type is not generated and the next group type in the sequence is used instead. With this method, the desired repetition rate for every group type is implicitly defined in a very flexible way for the broadcaster or service operator.

References

- [1] EBU Universal Encoder Communications Protocol UECP, Version 5.1, European Broadcasting Union, 17A Ancienne Route, CH-1218 Geneva, Switzerland, Aug. 1997.
- [2] CEN ENV 12313-1, Traffic and Traveller Information (TTI)-TTI Messages via Traffic Message Coding, Part 1, Coding Protocol for Radio Data System-Traffic Message Channel (RDS-TMC) using ALERT-C, European Committee for Standardisation (CEN), 36 rue de Stassart, B-1050 Brussels.

12

RDS Demodulators and Decoders

12.1 Introduction

In this chapter, the functionality of a radio data decoder and the microcomputer that controls the PLL tuner is explained. Existing ICs from various manufacturers for the RDS decoder/microprocessor (MCU) are mentioned. Then, the implementation of RDS in the three main categories of consumer receivers—that is, car radios, home hi-fi, and portable radios—is discussed. Some known plug-in cards with an RDS radio for PCs are briefly presented, and the chapter closes with a section about professional software RDS data monitors and data analysers for PCs and laptops in particular.

12.2 General Principles

12.2.1 RDS Demodulator/Decoder Technique and Functionality

Figure 12.1 shows the radio data demodulator/decoder in relation to the other parts of a VHF/FM receiver equipped to use the Radio Data System. The decoder accepts the multiplex signal from the output of the FM discriminator as its input, and feeds its output to a microprocessor. This microprocessor drives a display, controls the tuning of the receiver, and also performs some of the later stages of decoding the radio data signal. Microprocessor systems are, of course, most commonly incorporated in many of the more sophisticated modern receivers, employing frequency synthesised tuning (PLL) to control these tuning functions and the presets chosen by the user. The RDS decoder

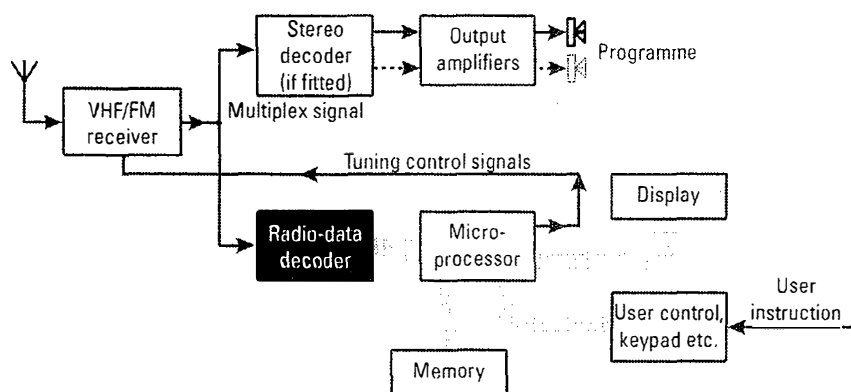


Figure 12.1 Typical block diagram of an RDS radio. (Source: EBU.)

can therefore be regarded as a logical extension. Such a control processor makes it possible to achieve better functionality and user friendliness, and eventually it will become an integrated part of the receiver.

Considering the functions of the radio data demodulator/decoder in a little more detail, six principal stages in the radio data demodulation/decoding process can be identified:

1. Demodulation of the 57 kHz suppressed-carrier amplitude modulated signal;
2. Decoding of the biphase symbols;
3. Recovery of the bit rate clock;
4. Recovery of group and block synchronisation;
5. Application of error detection and/or correction;
6. Decoding of address information and message codes.

All these stages can be implemented by a single microprocessor system. The techniques used to perform these functions are described in quite some detail in the relevant annexes of the RDS/RBDS specifications.

As an example of how this concept was implemented in a 1995 high-end car radio designed by one large European manufacturer, the following information may be of some interest. This example uses a powerful 8-bit single-chip microcomputer from Motorola's 68HC11 family (with PLL clock system, 32 KB of ROM, 1,024 bytes of RAM and 640 bytes of nonvolatile EEPROM, powerful timers, etc.) and a single-chip RDS demodulator with integrated

57 kHz bandpass from either Philips or SGS/Thomson to obtain and process the continuous synchronous data stream and the clock frequency of 1.1875 kHz (57 kHz/48). The relatively high power of the microprocessor is necessary because, apart from the RDS functions, it must control the PLL tuning system, the display of a car radio, the functional keys of the radio, the sophisticated man/machine interface, the digitally controlled audio processor, the cassette player, the remote controlled CD changer, the traffic announcement recording system, the clock, and so on. Nearly all these operations must be done in real time. Multitasking capability is therefore necessary for the different logical devices, because some devices must run simultaneously.

Every 842 μ s (1000000/1187.5), the microprocessor will receive a new bit from the continuous RDS data stream delivered by the RDS demodulator chip, load it into a 26-bit software shift register, and process the RDS data in a 26-bit sequence. However, this is only true if the data stream is truly synchronous; that is, the position of each bit in the data stream can be clearly interpreted. Loss of only one bit means that the microprocessor is getting asynchronous data. In that case, a more time-consuming task needs to be done to obtain block and group synchronisation.

To acquire group and block synchronisation at the receiver (for example, when the receiver is first switched on, or tuning to a new station, or after a prolonged signal fade), the syndrome (see Appendix B) must be calculated for each received 26-bit sequence. That is, on every data clock pulse, the syndrome of the currently stored 26-bit sequence (with the most recently received data bit at one end and the bit received 26 clock pulses ago at the other) is calculated on every clock pulse. Then, with every new incoming bit (842 μ s), a complete multiplication with the H-matrix (see Appendix B) has to be performed with all the 26 bits in the shift register. As a result, the 10-bit syndrome will be obtained. It must then be compared with the six known syndromes of the specified offsets A (block 1), B (block 2), C (block 3 for group type A), C' (block 3 for group type B), D (block 4), and E (occurs only with RBDS and detects MMBS data blocks in multiples of 4 in the RDS data stream). If a match occurs with a consecutive syndrome, 26 bits later ($26 \times 842 \mu$ s) after 22 msec, then the microprocessor is synchronised with the data stream. RDS synchronisation thus occurs when two consecutive RDS blocks in series have been detected.

If RDS reception quality is poor, this task requires a lot of processing power; but if the reception is good, the decoding task is, of course, much shorter. With mobile data reception, the RDS data stream can be full of errors, and a temporary 50% error rate is not uncommon. This is usually caused by the low RDS injection level used by the broadcaster (± 1.2 kHz in some critical cases, while ± 2.0 kHz is typical for the large majority of RDS implementations).

Another cause can be the simultaneous use of the ARI system (see also Appendix C, giving more detail about RDS data reception reliability). However, since the sequence of the syndromes is known, the decoding process can work as a “flywheel” mechanism, which is separately explained below. If an unknown syndrome is detected, the respective block is bad; but if block 2 is bad, the whole data group may be unusable unless error correction is used. However, the latter has to be used with caution because before it can be applied, the type of error has to be identified before it can attempt any corrections—and even then it can generate an error, which is less problematic for data used for display only (e.g., PS and RT).

It is very important to detect loss of synchronisation as soon as possible. One possibility is to check the syndrome continuously for acquisition of synchronisation. However, errors in the channel will make it difficult to continuously receive the expected syndromes, and therefore the decision must be based on the information from several blocks (e.g., up to 50 blocks). Another possibility is to check the number of errors in each block and base the decision on the number of errors in 50 blocks.

One possibility for detecting block synchronisation slips of one bit is to use the PI code, which does not usually change on any given transmission. If the known PI code is received correctly but is found to be shifted one bit to the right or to the left, then a one-bit clock slip is detected. The decoder can then immediately correct the clock slip.

12.2.2 Principles of the RDS Block Synchronisation System

The flywheel mechanism, used as a block synchronisation system in RDS, may perhaps be more easily understood with the aid of the simple mechanical analogy [1]. To develop that analogy, we first consider a conventional block synchronisation system, as illustrated in Figure 12.2(a). Here, the boundaries of blocks are marked by fixed block synchronisation words.

If we represent the received data stream as an endless belt, then these block synchronisation words may be represented as fixed markers on the belt, as shown. In the decoder, we must have a counter that is clocked at the bit-rate and that modulo the block-size. This counter may be represented as a slotted roller whose circumference is equal to the distance between the markers on the belt. It is easy to see that to synchronise the roller with the belt, all that is necessary is to allow the roller to slip until the slot meshes with one of the fixed markers. Once synchronised, the roller and the belt will remain in synchronism, even if some of the markers are damaged or missing. This illustrates the block-synchronisation flywheel system that is needed to enable the decoder to

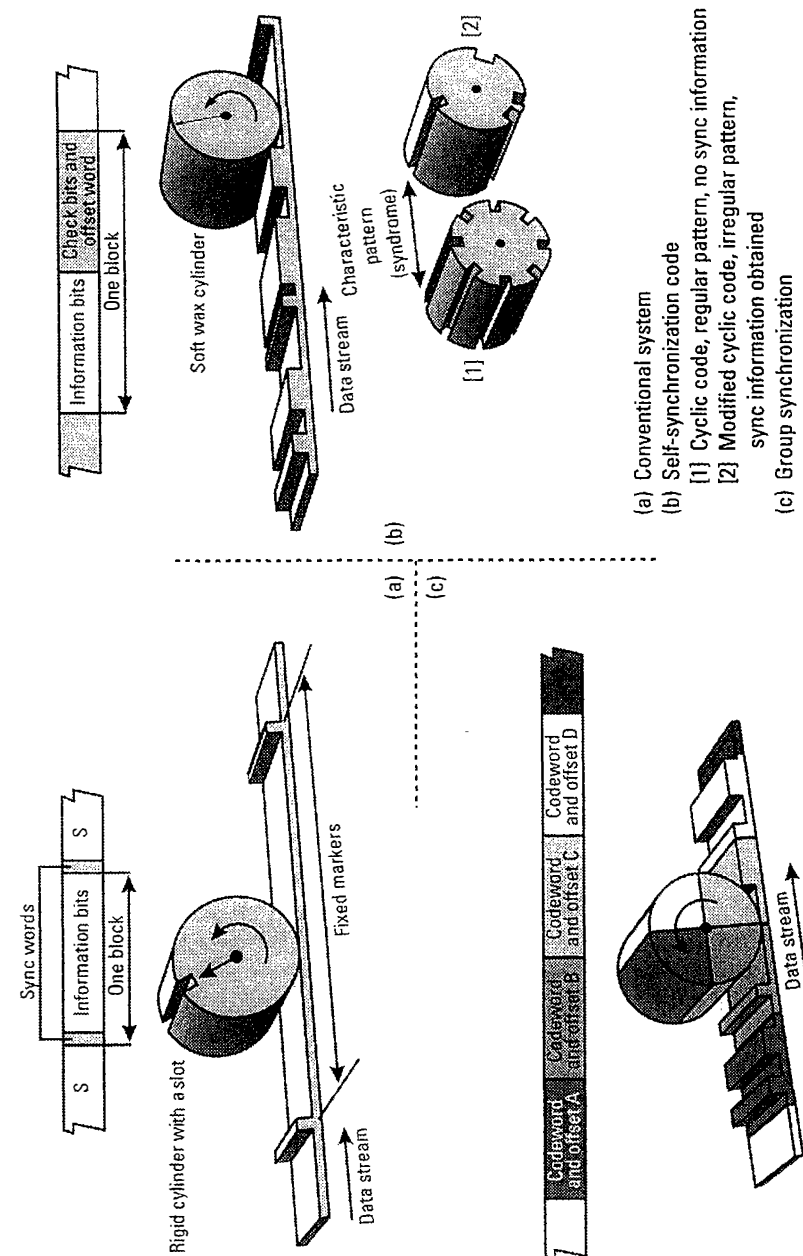


Figure 12.2 Mechanical analogies of the block synchronisation system. (Source: BBC/EBU.)

remain locked in synchronisation with the received data stream, especially when the latter is heavily corrupted with errors.

The disadvantages of a conventional block synchronisation system are also apparent from this analogy: Space must be allocated in the data stream for the markers, and these markers have to be clearly recognisable amongst the other data in the stream. Although these difficulties can be overcome (many data systems work this way), the particular requirements of radio data within an FM multiplex, favour a novel approach [2].

Using a similar mechanical analogy, the underlying principle of this novel block synchronisation system is illustrated in Figure 12.2(b). Here, the received code words are represented as a rack with *irregular* teeth, and the decoder in the receiver is represented as a soft-wax roller, which is capable of taking an impression of the rack as it is rolled along. Again, the circumference of the rotating roller is chosen to be equal to the distance between block (code word) boundaries on the rack. If the roller is rolled along the rack, starting at the beginning of the code word and ending at the end, then the resulting impression on the circumference of the cylinder will contain all the information about that code word. If the wax roller is subjected to further processing, analogous to the process in the error-protecting decoder, it is possible to see that the initial impression on the roller could be converted to one that depends not upon the transmitted message but only on the errors in the received code word. This pattern is analogous to the characteristic pattern or "syndrome" of an error-protecting decoder (see Appendix B).

If the movement of the roller is started and ended away from code word boundaries, the resulting first impression on the roller would comprise parts of two separate code words. It is a remarkable fundamental property of a conventional cyclic, or shortened cyclic code, that the characteristic pattern (syndrome) obtained by applying the error-checking process to such a mixture will, with high probability, be the same as for that obtained from one complete valid code word. In our analogy, we represent this case by the cyclically symmetrical pattern shown on the lower left-hand roller in Figure 12.2(b). Clearly, such a pattern would not provide reliable block synchronisation information.

If, however, the cyclic nature of the code is destroyed, which is done in RDS by adding binary offset words to each transmitted check word, an asymmetric pattern will result, as illustrated by analogy with the pattern on the roller in the bottom right of Figure 12.2(b). It is easy to see that such an irregular pattern can provide the necessary synchronisation information.

Block synchronisation is thus first obtained by trial and error, processing each 26-bit sequence until the expected characteristic pattern results. With a

high probability, this will occur only when the processed 26-bit sequence comprises one complete code word.

Different offset words added to each check word will yield different characteristic patterns, and in RDS, four different offsets are used in each data group to identify the four blocks that form the group. This may be illustrated by developing the mechanical analogy, as shown in Figure 12.2(c). There, the circumference of the wax roller has been increased by a factor of four, compared with that of Figure 12.2(b). Then, after it has been rolled along the section of the rack that represents the four blocks comprising a group, four different characteristic patterns will result around the circumference of the roller, as illustrated by the different shades in that figure.

It should be noted that once one characteristic pattern has been found, the rest follows in cycle sequence. Thus, all the necessary group synchronisation information can be obtained within one block length, and this provides rapid data acquisition.

Here is a short summary of this novel group and block synchronisation system. The beginnings and ends of the data blocks may be recognised in the receiver/decoder by using the fact that the error-checking decoder will, with a high level of confidence, detect block synchronisation slip. The blocks within each group are identified by carefully chosen 10-bit binary words (offsets) that are added (modulo two) to the CRC check words such that offset word A is added to block 1 in each group, offset word B is added to block 2, and so on. For more details, see Appendix B.

12.2.3 Error Correction and/or Detection

The error-protecting code that is used in RDS is an optimal single-burst error-correcting code and is capable of correcting any single burst of errors that spans five bits or less. However, the use of the full error-correcting capability greatly increases the undetected error rate and thus also reduces the reliability of the block synchronisation system. In most experimental decoders used for RDS field trials, the following restrictions were observed when performing error correction:

1. When the decoder is searching for block and group synchronisation (e.g., on switch-on or on retuning the receiver to a different station), the error-correction capability of the code is not used at all. This allows the full error-detecting capability of the code to be used to detect synchronisation slip.

2. When the decoder has acquired group and block synchronisation, the error-correction system should be enabled, but should be restricted by attempting to correct bursts of errors spanning one or two bits. The encoder should attempt to detect (and then discard) blocks with longer bursts of errors.

12.3 RDS Integrated Circuits and Chip Sets

The major manufacturers of RDS components, having made them by the millions, are Philips Semiconductors and SGS-Thomson. The references for their current circuits are as follows:

- *Philips*: SAA6579T (demodulator and integrated 57 kHz bandpass filter). SAA6588 is an RDS preprocessor which, in addition to the demodulator and integrated 57 kHz bandpass filter, includes improvements resulting in more reliable data reception during weak signal input. Also, it performs RDS block detection, error detection/correction, synchronisation, flywheel, bit slip correction, and data processing control. CCR520S, CCR526S, and CCR610S are RDS-specific complete chip sets for high-end RDS/EON car radios that include the MCU with RDS-specific processing software. CCR991 and CCR922 are RDS-specific 8-bit MCUs with software for RDS/RBDS and MBS/MMBS (only CCR922) preprocessing.
- *SGS-Thomson*: TDA7330B or TDA7330BD, TDA7331B, or TDA7331BD, and TDA7479 (all these are single-chip demodulators with an integrated 57 kHz bandpass filter). TDA7332 or TDA73312D are 57 kHz bandpass filters. ST7285A5 is an 8-bit RDS-specific MCU (user ROM of 48 KB, data RAM of 3 KB) with an integrated RDS demodulator and a 57 kHz bandpass filter.

Other manufacturers in the years since 1987 were Bosch-Blaupunkt (in association with Texas Instruments), Sanyo (LC7070, LC72721, and LC72720N—single chips with filter and demodulator), Tokyo Cosmos, NEC (uPC2539GS—filter and demodulator), Siemens, and Rohm (BU1920F—filter and demodulator).

Prices have now become very competitive, and are generally at levels where the RDS functionality no longer adds significantly to the receiver price, except at the low end of the market.

12.4 Consumer Receivers

12.4.1 Car Radios

There are about 50 manufacturers in the European market with more than 400 different models, from high-end models down to the midrange and even down to low-end models, but the U.S. market still lags behind. We have to distinguish between first- and second-generation RDS; that is, in the first case only PI, PS name, AF, TP and TA flag features are supported, while in the second case, there is also EON (TA, AF, and PTY), PTY, CT, MS and even RT).

In the early stages of certain new products, especially from less well-known companies, some of the basic RDS features could have been left out and some malfunctioning of the RDS option was not uncommon. At a later stage of these products, improvements have been achieved, especially if the BBC's services for testing receivers were used.

Those manufacturers that have been in this market now for many years already have achieved, in the majority of cases, very fine products at very competitive prices, but to this category belong only, perhaps, a quarter of the 50 manufacturers. Fortunately, they have also made the largest number of the existing RDS radios sold.

In the United States, Delco, Denon, and Pioneer are among those companies that lead the RDS car radio market. They collaborate closely with the American carmakers to provide OEM products and in 1997, Ford, General Motors, and Toyota have all announced that they will start to offer American cars equipped with RDS radios (see Figure 12.3).

European carmakers have also started to offer their cars with RDS radios to the U.S. market.

12.4.2 Home Hi-Fi

There are now hundreds of models from about 25 different manufacturers on the European market. The U.S. market still lags behind. Prices range from very high to reasonably low. All support PS, some support AF, and several of them support RT, PTY, and CT. In this kind of product, the price of the RDS component is not significant anymore; therefore, we expect that in the future most of these models will be equipped for RDS.

12.4.3 Portable Radios

There is still some reluctance toward this kind of product on the side of the manufacturers, while broadcasters believe that, especially in this area, RDS

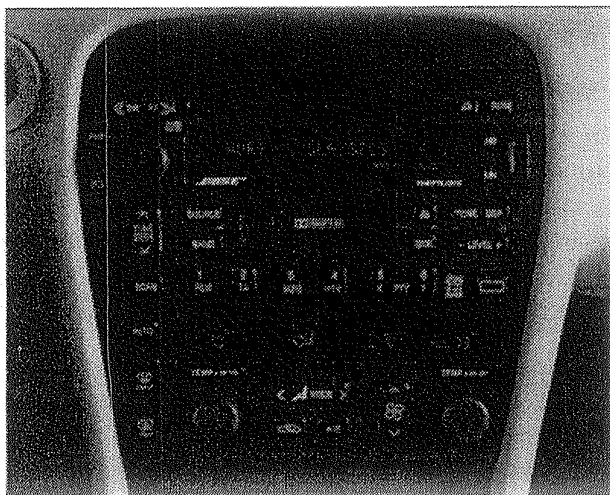


Figure 12.3 GM/Cadillac will be one of the first U.S. carmakers to offer RDS in 1998. (Source: GM/Delco.)

could significantly simplify the functionality and user friendliness of the radio for nontechnical people (imagine, as an extreme consumer case, your grandmother), especially with the PI, PS and AF features. Of course, PTY and RT could also be very attractive options if they were more widely implemented by broadcasters, a situation that is likely to occur with the start of DAB implementations in various parts of Europe. Some of the radio programmes to be found in the DAB ensemble will just be a duplication of the already existing FM programmes, but then it will be necessary to pop these programmes up with programme-associated data services such as PTY and RadioText.

Manufacturers that have portable RDS radio models on the European and U.S. market are Sangean (also sold as Uher or SuperTech), Siemens, Sony (notably the FM radio Walkman SRF-M48RDS, see Figure 12.4), and Grundig (see Figure 12.5). Prices are in the midrange with a trend toward less expensive models, with the cheapest being around USD \$60.

12.5 Radios on Plug-In Cards for Personal Computers

12.5.1 The Philips SMART Radio

In 1996 in the United States, Philips Semiconductors showed a new chip set (TEA5757H, PCF8574T, TDA1308T, SAA6579T, CCR921, TEA6320T,



Figure 12.4 The Sony RDS Walkman radio SRF-M48. (Source: EBU.)



Figure 12.5 Grundig made the world's first portable RDS radio: the 1994 model YB 500. (Source: Grundig.)

TEA6360T, and TDA1517P) permitting the design and manufacture of add-on boards for IBM-compatible personal computers (see Figure 12.6). This is also available also as the OM 5604 multimedia FM receiver module, which is fully shielded to overcome the extreme electrical noise found in a PC environment.

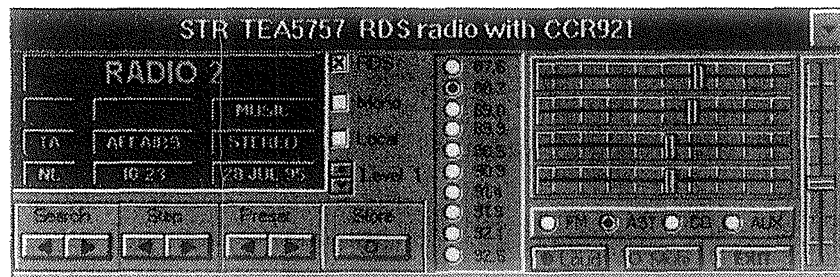


Figure 12.6 Philips PC radio: software option 1. (Source: Philips.)

Philips has designed Windows reference software with Pascal source code to simplify the design task for the final product (see Figure 12.7) [3].

12.5.2 ADS Radio Rock-It RDS

In 1995, the Californian multimedia company Advanced Digital Systems (ADS) developed an FM stereo receiver/RBDS decoder PC plug-in card called

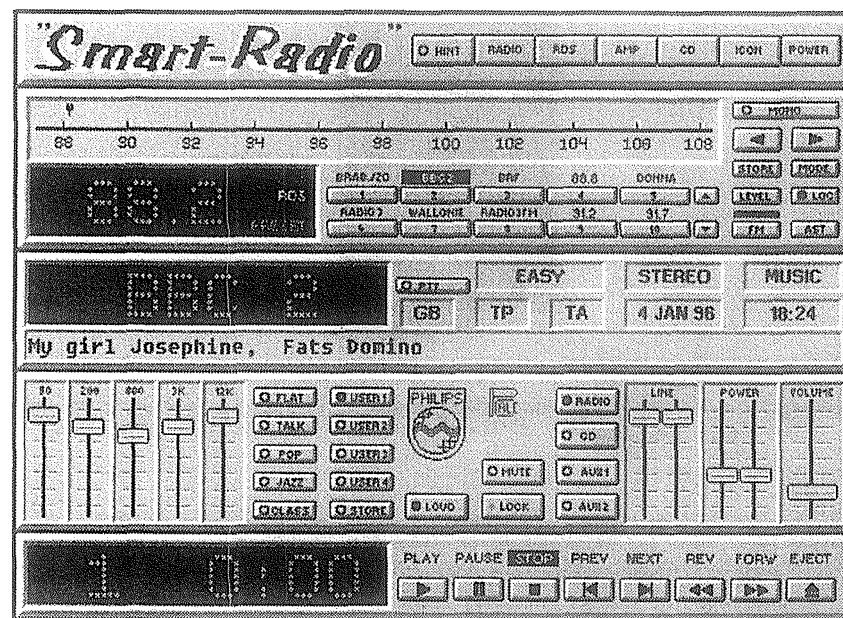


Figure 12.7 Philips PC radio: software option 2. (Source: Philips.)

“Radio Rock-it RDS.” This unit has more than one application, being capable of displaying RBDS data or recording the broadcast programme to hard disk for later listening, and even includes a five-band graphic equaliser for enhancing broadcast or other input material. It is suggested that this system could be used to record the latest weather reports, allowing a weather-on-demand service [4].

12.5.3 The GEWI Radio G211 and TMC Office Decoder

The GEWI radio G211 is an RDS radio built into the small type 1 PCMCIA card. It comes with Windows software that installs a Window PC radio and an RDS decoder for data monitoring (see Figures 12.8 and 12.9).

The TMC office decoder is an additional piece of Windows software that enables TMC message decoding in conformity with the ALERT-C standard (see Figure 12.10).

12.6 RDS Data Monitors and Analysers for PCs

12.6.1 General Remarks

In this section, we present all the known professional RDS monitors and data analysers. Several of these products have been in existence for many years, and they have been upgraded several times to respond to many user requirements. They are all superb products on their own. However, our experience is that, for professional reasons, it is quite an advantage to have more than one of these software packages readily available and installed on the PC. The functions normally offered by each of these products are indeed numerous and, in terms of user-friendliness for any of the particular applications, there is frequently one or the other product preferred, which by no means decreases the value of the then nonpreferred product. There is, rather, a more subjective issue that the designer of such a software product could easily match for the individual case. Prices for

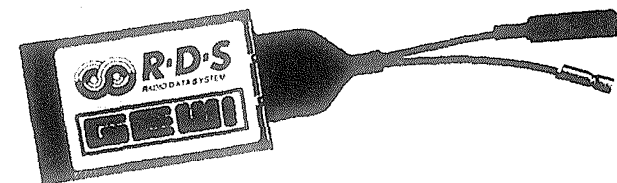


Figure 12.8 GEWI's PC card RDS radio with TMC software. (Source: GEWI.)

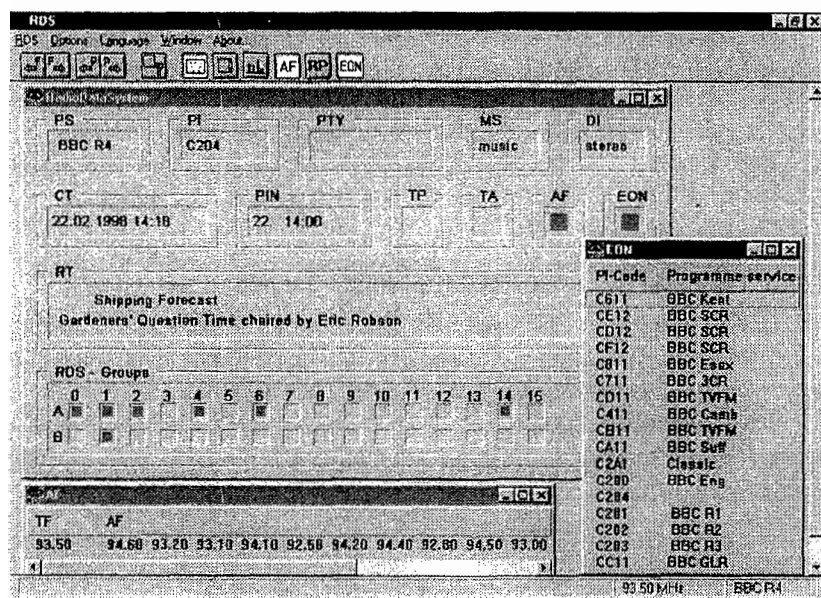


Figure 12.9 A screen image from the GEWI RDS decoder software showing BBC Radio 4 tuned and displaying the basic RDS features from that transmission, including PS, PI, PTY, MS, DI, CT, PIN, AF, EON, RT, and the groups used. Tiled over this display at the lower edge is part of the AF list, and on the right, part of the EON list showing PI and PS. (Source: EBU.)

these packages are nowadays very competitive and, as already indicated, the quality level achieved within these products is generally very high, so each one of them is in a way, a jewel in itself.

12.6.2 AUDITEM AUDEMAT Rx_MCRDS

This is Windows software (with optional language choice, English or French) for RDS data monitoring and analysis (see Figure 12.11). It comes with a kit that includes an RDS receiver unit with data output via a special interface cable that connects to the serial interface port of the PC.

12.6.3 AZTEC FM Explorer Version 3.0

This is a Windows software package for decoding and analysis of RDS data, radio frequency (RF), and audio measurements (see Figure 12.12). In addition, it needs an AZTEC RDS receiver connected to the PC. The FM Explorer

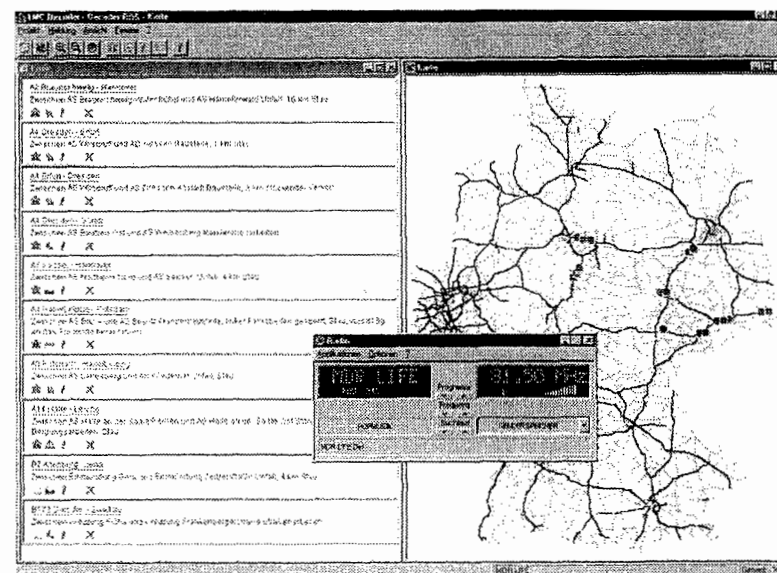


Figure 12.10 GEWI's PC card RDS radio with RDS decoder software and optional TMC software. (Source: GEWI.)

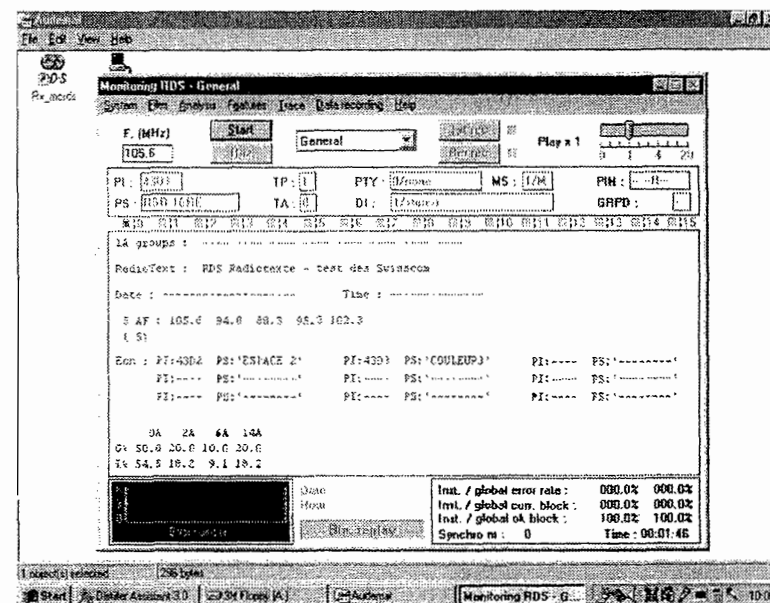


Figure 12.11 A typical screen from the AUDITEM AUDEMAT Rx_MCRDS. (Source: Auditem.)

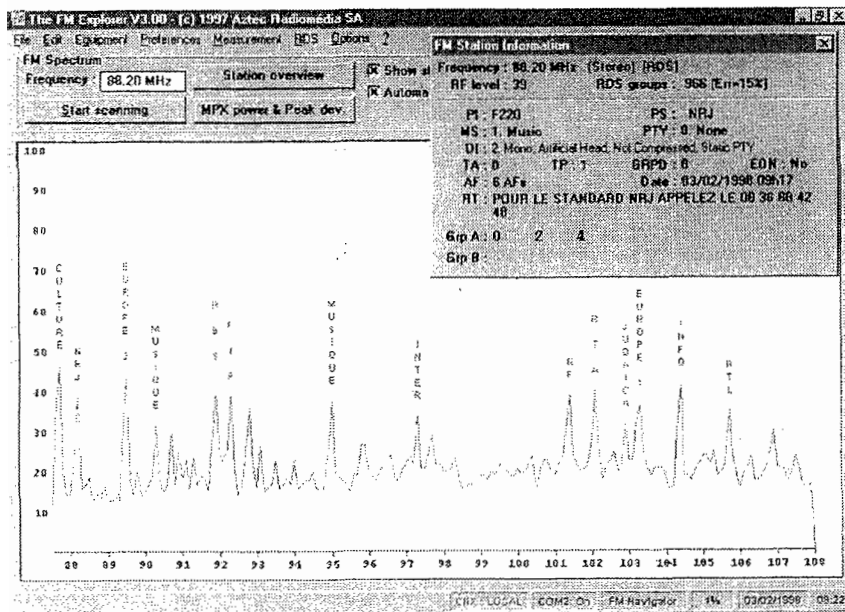


Figure 12.12 An FM band-scan made with AZTEC's analysis and decoding software. (Source: AZTEC.)

combines in one product a multitude of RDS functions with measurement and statistical analysis capabilities, including that of the RF level and the modulation characteristics.

12.6.4 The RDS Software Decoder Version 2.0 from Franken-Team

The RDS Software Decoder is a DOS application for RDS reception that requires an RDS receiver to be slightly modified; that is, the digital signals RDS DATA and RDS CLOCK need to be wired from the RDS demodulator chip to a suitable socket (e.g., a 3.5-mm stereo phone jack). An interface cable, which includes a buffer for decoupling, is provided. The decoder is suitable for analysing all RDS/RBDS features as specified in the latest versions of both standards (see Figure 12.13). An RDS event recorder makes it possible to store dynamic events such as change of PI or RT. The logic analyser makes it possible to record RDS data with various trigger modes for later analysis. Up to 2,100 groups of RDS data, including check bits (three minutes), can be recorded.

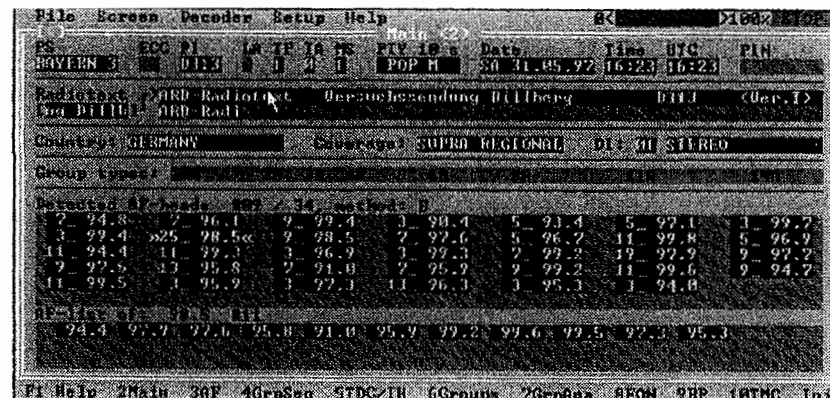


Figure 12.13 A typical screen from Franken-Team's RDS Software Decoder. (Source: Franken-Team.)

12.6.5 Schümperlin's PRD-3 and PRDLIB16.DLL

The PRD-3 is a DOS software program for decoding, monitoring, and analysing the RDS data flow (see Figure 12.14). The PRD-3-C comes with an interface cable that needs to be connected to the serial port of the PC and the RDS DATA OUT and GROUND pins of the RDS demodulator chip in an RDS receiver.

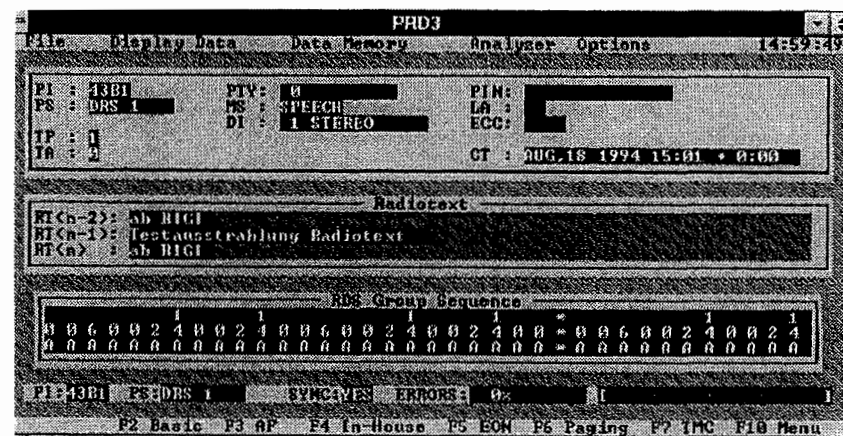


Figure 12.14 A typical screen from Schümperlin's PRD-3. (Source: Schümperlin.)

PRDLIB16.DLL is a dynamic link library for Windows (16-bit). It allows one to create specific RDS decoder applications in just a few minutes. Any programming language that supports DLLs can be used (e.g., Visual Basic, Delphi, C++, etc.). This DLL does all the low-level decoding of the RDS data stream (block and group synchronisation and error correction/detection). The user can thus concentrate on his or her own application.

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13

Outlook: RDS and Other Broadcast Data Systems for Radio

13.1 Introduction

This chapter reviews other radio data systems that are already used for data transmissions in the allocated frequency bands for terrestrial or satellite radio. The possibilities offered by these systems are compared with RDS wherever this is possible. A forecast is made about the market impact from the present point of view for all these systems. The following systems are being reviewed: AMDS and Digital Radio Mondial, the latter for AM broadcasting replacement by a new digital broadcast system; the high-speed data systems DARC/SWIFT, HSDS, and STIC for FM broadcasting; Digital Radio (Eureka 147-DAB), ADR, DSR, DVB, and WorldSpace.

13.2 LF, MF, and HF Broadcasting

13.2.1 AM Data System

Tests in the 1980s showed that low-rate data could be carried by LF and MF transmissions. For many years, the BBC 198 kHz transmitter has used phase modulation of the carrier to achieve 50 bps; however, tests on "Hochschule für Verkehrswesen Dresden" showed that it was possible to add a data stream of 200 bps using a phase modulation of $\pm 15^\circ$ to an AM transmitter, with minimal degradation of the received audio quality. Since 1986, extensive field trials have

been conducted to find an appropriate baseband coding to match the bit error conditions of AM channels in LF, MF, and HF broadcast bands.

The AM Data System, or AMDS, as it has come to be known, owes its origin to these trials. In 1994, the AMDS specification was expanded with the help of the EBU, but it concerns only the baseband coding for data broadcasting on LF, MF, and HF. Use was made of the experience gained by those broadcasters in Germany, France, the Netherlands, and the United Kingdom. They had conducted field trials with phase modulation as the modulation method, permitting a total bit rate of 200 bps. For example, in Germany, a national working party had already attempted to draft the specification, and the EBU made use of this to considerably widen its scope. In addition, in 1995, the ITU-R Working Party 10A prepared ITU-Recommendation BS.706-1 for AMDS. However, there are major problems with all the attempts made so far to get AMDS off the ground. One problem is that the modulation method used is incompatible with single-sideband broadcasting (SSB), which could in principle be used more and more for HF broadcasting. In addition, AMDS is incompatible with AM stereo, used in the United States. For these two reasons, the system has gained little support so far, and there are practically no suitable receivers apart from a few prototypes (mainly used for TMC, and DGPS field trials on LF and MF in Germany).

For HF broadcasting where changing ionospheric propagation conditions require broadcasters to use several HF bands during the course of a day, AMDS (as tested in these field trials) would definitely have been of some interest if SSB were not around the corner. In 1996, other alternatives were still being studied; for example, in the United States in the context of RBDS, and in Hong Kong by ID logic involving several large HF broadcasters from Europe and North America. Therefore, it is quite possible that a solution will soon present itself that overcomes the limitations that have so far hampered the success of an RDS for AM broadcasting.

The AMDS features described in the EBU's specification broadly follow the ideas of the RDS features, and many will be easily recognised, such as AF, DGPS, IH, RT, TDC, and TMC. Among the new features are additional tuning information (ATI), basic tuning and switching information (BTI), scheduling information (SI and SIS), and time information (UTC). SI and SIS pick up the idea of the EON feature of RDS and provide scheduling data for receivers to be stored in their memory. This feature is designed for HF applications, where programme breaks may occur in the order of every 15 minutes to 1 hour, resulting in many frequency and programme changes.

In 1996, there were still a number of test transmissions in LF, MF, and HF from European-based transmitters. One LF transmitter at 153 kHz for Deutschlandradio in Germany was providing TMC. Two MF transmitters in

Norway were providing DGPS to cover coastal waters, and one transmitter in Germany at 756 kHz was also providing DGPS. Receivable over a wide area were the HF transmissions from Deutsche Welle in Germany, at 6,140 kHz and 13,780 kHz in German and at several other frequencies carrying foreign languages.

13.2.2 New Developments Using Digital Modulation

Looking into the future of LF, MF, and HF broadcasting, it is more and more likely that analogue AM broadcasting will soon be replaced in these frequency bands with new radio systems using digital AM. These all will, of course, contain a radio data channel with features similar to those used in RDS.

At the time of this writing, the following steps in this development had already been completed [1]:

- *October 1994*: ITU Study Group 10 issues a report about digital AM;
- *November 1994*: First tests on MF in Berlin by Deutsche Telekom using SKYWAVE 2000 by Thomcast;
- *February 1995*: A European working party is formed to find a consolidated approach;
- *June 1996*: EUREKA accepts the new project EU 1559 Narrowband Digital Broadcasting (NADIB). Consortium members included Deutsche Welle, Radio France International, Telefunken, Thomcast, Sony, Deutsche Telekom, Teracom, and the Fraunhofer Institute;
- *December 1996*: Start of one-hour daily test transmissions on short waves from Jülich (Germany);
- *April 1997*: Establishment of the new collaborative project Digital Radio Mondial (DRM), led by Voice of America and aiming at the development of a digital short-wave broadcasting system that is resilient to fading, which characterises analogue shortwave broadcasting today.

13.3 FM Broadcasting

13.3.1 The Future of RDS

RDS will remain unchallenged in the market of FM broadcasting for many years to come, and today one can say with some confidence that no competitor to RDS is really on the horizon. The international scene for system standards

clearly requires that other subcarrier systems used in FM broadcasting be fully compatible with RDS. This being a fact that cannot be easily changed, RDS will most probably remain in service as long as analogue FM broadcasting exists; that is, definitely for another 20 years.

RDS receivers have been marketed since 1987. The largest proportion have been car radios, and many of them are now also supplied as a standard-fit radio within a newly purchased car. The number of these receivers is steadily increasing, and there were more than 50 million in use by the end of 1997, as can be seen from Figure 13.1. However, many of these first-generation receivers only implemented the so-called five basic RDS features—PI, PS, AF, and TP/TA—for the simple reason that broadcasters using transmitter networks have first implemented these features for economic reasons.

In the second generation, these five basic RDS features were combined with EON. For some time, this situation has been changing, and we can already speak of a third generation. Broadcasters now give more attention to using the programme-related RDS features, such as RadioText and PTY, one of the reasons being that these will be used in DAB. Therefore, more and more RDS receivers now come onto the market that also implement these features. Originally, these were mainly home receivers, but now car radios will also implement RadioText. For safety reasons, however, there must be a switch with which the user can enable or disable RadioText—as a default, RadioText must be switched off in car radios.

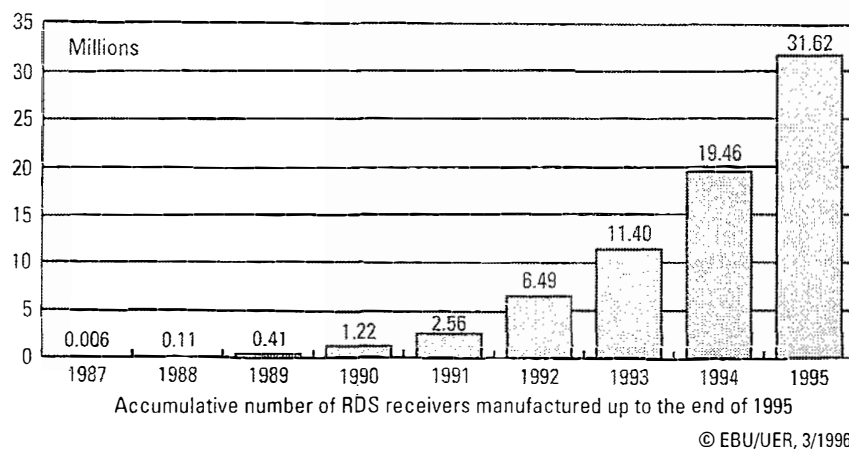


Figure 13.1 Development of the RDS receiver market. (Source: EBU.)

The large majority of consumer electronic manufacturers around the world support RDS technology. In Europe, prices for the RDS option are now only slightly higher than for a radio without RDS. There are already many manufacturers that equip almost all their FM radio products for the European market with an RDS module. Therefore, if the development continues with the same speed as in the past, we should soon reach the state where almost all new radios are equipped for RDS performance.

13.3.2 High-Speed Data Systems

13.3.2.1 General Considerations

The systems considered here use the frequency range above 61 kHz in the FM multiplex, and only those that are compatible with RDS will be mentioned. These systems achieve a significantly higher data rate than RDS.

Generally speaking, FM subcarrier systems appear, under certain conditions, to have some adverse effects on the reception of the audio carried on the parent FM transmission. This is particularly true in the presence of multipath propagation; that is in areas where the radio waves are bounced back by high-rise buildings or other obstacles, such as mountains. The significance and acceptability of these effects varies considerably, and depends on several factors: injection level of the subcarrier signal, its modulation system (where digital systems are less damaging), the particular type of receiver (fixed, portable, or car radio) and the way it is designed, the nature of the wanted radio programme (i.e., whether there is frequently low-level audio as in classical music or whether there is a continuously high-level sound) and the propagation environment (most critical are mountainous regions and cities with high rise buildings).

The addition of FM subcarrier systems is permitted only if they use all together no more than 10% deviation of the total FM carrier deviation permitted, which is ± 75 kHz. If several subcarriers are used, it may be necessary to reduce the deviation for the main audio programme. Also, it is important to examine whether a subcarrier system complies with ITU-R Recommendations BS.412-7 and BS.450-2; that is, it has no adverse effect on the established protection ratios used for frequency planning.

13.3.2.2 DARC/SWIFT

Data Radio Channel (DARC) was developed by NHK and was, up to the end of 1997, mainly used in Japan (16 kbps) and partly also the United States (by a company called Digital DJ), occupying a bandwidth of 35 kHz centred on 76 kHz. The DARC injection level changes with the level of the audio

programme modulation; that is, it is dynamic and depends precisely on the level of the stereo difference signal. The system characteristics are generally described in ITU-R Recommendation BS.1194-1 [2, 3].

In Europe, the DARC system is getting increasingly popular for the introduction of special open or subscription data services, which will be broadcasted to specific user groups. DARC was extensively tested and further developed by the Eureka 1197 Project "System for Wireless Infotainment and Forwarding Teledistribution" (SWIFT), which used the DARC modulation scheme (transmission layer 1 and 2) but a different baseband coding (transmission layer 3). This project started in 1994 and involved the telecommunications companies of France, Germany, and Norway and the broadcast transmitter operator, Teracom in Sweden. The project has produced a European ETSI standard that was adopted in 1997 [4]. First implementations are foreseen in Austria, France, Germany, the Netherlands, Norway, Sweden, and Switzerland, beginning in 1998.

To achieve a data service range as large as that of the audio programme, a higher data injection level is required (typically ± 7.5 kHz) than the one used for RDS (typically ± 2 kHz). Thus, when RDS and DARC are implemented, the maximum deviation of the audio programme has to be somewhat reduced to ensure that the total deviation remains within the ± 75 kHz maximum permitted.

At the time of writing, the DARC system in Europe aimed at a niche market; that is, the provision of radio data channels to small portable data receivers (e.g., made by Casio, Sharp, and Sony) and PCs, with the receiver being implemented on a PC card (PCMCIA) using Japanese ICs from Sanyo or Oki. Use is also made of a conditional access technique with the key being electronically provided through a receiver identification code, permitting the user to be charged for the services provided. Services to be provided could be electronic newspapers, stock market and other financial data, an enhanced TMC, and the DGPS. Digital DJ (United States) started to launch similar services in the major U.S. metropolitan areas (see Figure 13.2).

Since 1996, the DARC technology has been promoted by the DARC Forum, which functions in a similar way to the RDS Forum, with some of the members participating in both.

The DARC Forum holds the view that the DARC system is a flexible and transparent data channel. It is an intermediate system that can be implemented in a short time in order to make the transition from RDS basic data services to advanced digital radio (DAB) data services possible by using the existing FM network infrastructure, which already provides excellent coverage everywhere. Thus, the DARC system can be easily implemented, providing a good coverage

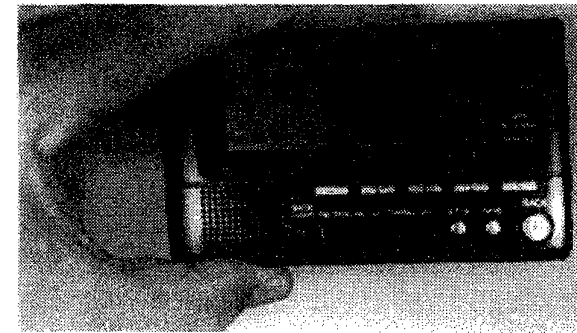


Figure 13.2 The Digital DJ low-cost DARC receiver from Sharp is designed to deliver a new kind of subscriber radio data service in the United States, Europe, and Japan. (Source: EBU.)

area and a high availability for mobile reception at a fairly low cost. DARC could also be considered to provide a good marketing test opportunity for future radio data broadcast services [5].

13.3.2.3 Other Subcarrier Systems

Another system is the Seiko Telecommunication System (United States), HSDS, used on some transmitters in America and Europe. HSDS achieves 19 kbps, occupying the 57–76 kHz range in the FM multiplex with the subcarrier on 66.5 kHz.

A third system, so far of interest only in the United States, is called MITRE Subcarrier Traffic Information Channel (STIC) centred on 72.2 kHz (with a net user data rate of 7.6 kbps) from the U.S. company, Radio Dynamics.

In the United States since 1994, the NRSC High Speed Subcarrier Subcommittee has sought to evaluate the three systems with the view of achieving agreement on a voluntary U.S. standard that would recommend either one of these systems or a combination that incorporated all their recognised optimal features after an agreed upon field evaluation under identical test conditions for the three systems (DARC, HSDS and STIC). In March 1998, this objective was declared to have ended up in a deadlock due to the fact that the interested parties (mainly the system proponents) could not agree upon a single solution. The results of the field tests, which revealed that all the three systems performed relatively well, were submitted to ITU-R Study Group 10. This group decided to incorporate the results into ITU-R Recommendation BS.1194-1, which now recommends all three systems.

13.4 Digital Radio DAB

13.4.1 Origins and Possible Evolution

The future is most probably set for DAB, which already is increasingly used on VHF and the L-band (1.5 GHz). DAB is a European standard of ETSI (first published in 1994) [6] and a world standard recommended by the International Telecommunications Union (ITU). The system has been developed over a period of some ten years (beginning in 1986) by the Eureka 147 Consortium, with the EBU coordinating the writing of the specification. DAB is already widely implemented in large parts of Europe and Canada. Several other countries in the world also experiment with this system. In early 1998, about 150 million people were potentially able to receive DAB. However, receivers were still expensive and therefore largely unavailable except for field trials. However, expectations in the WorldDAB Forum are high, and indicate that this is going to change in late 1998 [7, 8]. Most recently, some important technological breakthroughs were achieved. A single chip receiver was developed jointly by Hitachi and Roke Manor, and a DABman (DAB version of a Walkman) was developed by Bosch. Clarion has developed a fully integrated one-box car receiver. In addition, a small British software company, RadioScape, has developed a full software DAB receiver that uses a standard Intel Pentium chip PC for decoding, rather than dedicated integrated circuits specifically designed for DAB. This opens the door to a wide range of multimedia applications that could be implemented via software, downloadable to the receiver; for example, a laptop computer being able to process the complete 2.3 Mbps DAB multiplex in real time.

DAB has numerous advantages over VHF/FM broadcasting. It offers significantly better reception quality for both audio and data services; that is, it overcomes the adverse effects of multipath propagation, so badly experienced in VHF/FM broadcasting. DAB offers a high degree of ruggedness. In addition, DAB provides for a very high spectrum economy due to the single frequency network technique and, further, a high flexibility for assembling, even dynamically, a number of different audio and data services to the service multiplex, called the "ensemble." One ensemble would typically provide capacity for six stereophonic audio programmes (each with a bit rate of 192 kbps), each having its own programme-associated data channel PAD (32 kbps) and additional capacity for other radio data in both the fast information channel (FIC) and the auxiliary information channel (AIC) [9–11].

The choice for multiplexing the ensemble is so wide that in the extreme, all audio could be replaced by data, permitting one video channel with sound.

This is a key feature of DAB that permits broadcasters to "flex" the multiplex; that is, the bit rate allocated to individual services in the multiplex can be changed on a dynamic basis to meet the needs of the broadcaster and the public. This powerful DAB feature thus opens the door to multimedia radio with several new data services that are still being defined. For example, for DAB, a media object transfer (MOT) protocol has been proposed for the transmission of multimedia services (see Figure 13.3). However, in the already existing definitions, much effort has been made to preserve compatibility with RDS features wherever possible.

Of course, many broadcasters will for many years need to distribute their services in both VHF/FM and DAB. Nevertheless, with DAB, existing RDS services can develop further and improve. For example, the Traffic Message Channel (RDS-TMC) will most probably be significantly enhanced with the new bearer-independent protocol TPEG, as already mentioned in Chapter 7, to carry urban and interurban traffic and travel information, including public transport and tourist information.

13.4.2 Comparison of RDS and DAB Data Features

The data services in DAB are being called service information (SI), and those already defined in the DAB standard are being summarised in Table 13.1.



Figure 13.3 DAB makes it possible to implement multimedia services on DAB. During a 1997/98 field trial in Germany, SDR/SWF used the MOT protocol to broadcast pictures with CD covers of pop music titles on air. (Source: EBU.)

Table 13.1

DAB Service Information (SI) features as compared to RDS

DAB Feature	Position of Feature in DAB Multiplex	Transmission Capacity	RDS Comparison
Service-related data			
Service directory (part of MCI)	FIC	High	PI, ECC
Service label	FIC	High	PS
Frequency information	FIC	Medium	AF
Conditional access	FIC MSC	Medium	—
Programme-related data			
Programme language	FIC	Low	Lang.
Programme TYpe	FIC	Medium	PTY
Programme number	FIC	Medium	PIN
Foreground / Background	Audio	Low	—
Programme associated data (PAD)			
Dynamic range control	PAD	Low	—
Dynamic label	PAD	Medium	RT
Music / Speech / Off	PAD	Low	MS
Copyright	PAD	Low	—
Interactive text transmission system (ITTS)	PAD	Medium	—
Non-audio features			
Time and date	FIC	Low	CT
In-House	PAD/FIC	Low / Medium	IH
Transmitter identification	FIC/AIC	Medium	—
Paging	FIC/AIC	High	RP
Traffic Message Channel (TMC)	FIC/AIC	Medium	TMC
Emergency Warning Systems (EWS)	FIC/AIC	Low	EWS
Ensemble-related data			
Ensemble label	FIC	Very low	—
Announcements	FIC	Low	TP, TA
Alarm	FIC	Very low	PTY = 31
Other ensembles and services			
Other ensembles and AM / FM	FIC/AIC	High	EON

Reference is also made to how they correspond to RDS features; however, usually they are enhanced. An example is the service label ("BBC Radio One"), which has sixteen characters at maximum in DAB, but has only eight at maximum in RDS ("BBC R1"). The service label in DAB is thus eight characters longer than the PS name used in RDS. It was designed to give greater freedom in describing a service. To maintain compatibility with RDS, the service label is accompanied by additional information that allows up to eight characters to be suppressed in a receiver with a limited display. All features using a text display in RDS and DAB use the same character tables as those detailed in Appendix I.

The frequency information feature provides a cross-reference to alternative sources of service. It is similar to the RDS AF feature, which provides a list of alternative frequencies and permits programme continuity when a mobile receiver moves across coverage area boundaries and requires retuning to obtain better reception. Although DAB is suited to operation in a network where *all* transmitters operate on a single frequency network (SFN), DAB multiplexes may also be available via satellite or cable, and these multiplexes may operate in different frequency ranges and DAB modes.

Data capacities for DAB data services are significantly higher than is possible with RDS, and in Table 13.1 they are indicated in only very broad terms because the requirements depend on a wide range of options. "Very low" means a few bits per second and "high" indicates 10 kbps or more.

13.4.3 RDS/DAB Interoperability

When DAB services duplicate those radio programmes available on VHF/FM, and when DAB signals are not yet widely available (especially during the years when new DAB services are being introduced), there will definitely be areas where some services will only be available on VHF/FM. Then, the DAB frequency information feature will have to provide for cross-referencing to FM (and in theory, also to AM), and it shall consequently support the full range of radio frequencies foreseen for DAB, AM, and FM.

In the years 1996–1997, the RDS Forum established a working group to examine how various radio data features of the RDS and DAB systems could best be implemented by both broadcasters and receivers to allow a user to benefit from both systems used in his or her receiver. This was done with the view of avoiding confusion for the technically uninformed listener. Neither system should be modified, the only objective being to better understand how the system features should be applied to achieve these objectives. The findings of the working group are, at the time of writing, being considered for inclusion in the RDS guidelines that the EBU and the RDS Forum intend to publish during 1998.

13.5 Digital Radio by Satellite

Satellite radio is currently available in Europe via the digital satellite radio (DSR) system and the SES/ADR (ASTRA Digital Radio) system. DSR was only used in Germany, and it was unsuccessful in capturing a European market because it was conceived in the early 1980s for fixed antenna reception only. In the DSR implementation phase, starting in 1985, DAB was already being developed, and contrary to DSR, it was conceived for mobile reception while permitting fixed reception as well. This made DSR unattractive and, finally, redundant.

Some years later, in 1994, SES introduced on its ASTRA satellites the ADR system. Because of its limitation of fixed reception only (a similar limitation to DSR), it is likely to be around for only a few more years. ADR uses an analogue television signal to carry in a piggyback manner a modest number of radio channels as well as TV. In those European countries where the ASTRA satellite system is popular, ADR is inexpensive as a transmission medium, and receivers are available at a marginal cost increase to the ASTRA satellite TV decoders, which are generally available at low cost. ADR can be operated to include an in-house data channel that makes use of the Universal Encoder Communication Protocol, as described in Chapter 11. This permits the feeding of a network of terrestrial radio transmitters, where each individual transmitter can be fed in a regional context with RDS data as required for the terrestrial operation.

Another system to come soon is DVB-S. Intended primarily for digital television, it can provide radio to smaller sized dishes than ADR, but these dishes still have to be fixed and have a clear line of sight to the satellite.

The year 1998 may be a landmark year for digital radio by satellite, because a new radio system, called WorldSpace, will be launched and another digital radio system, Mediastar, may come in three years' time.

WorldSpace aims at providing low-cost digital satellite radio to portions of Africa, the Middle East, Latin America, the Caribbean, and Asia. The transmission system will not use DAB, but a proprietary system instead, details of which are not yet in the public domain. Two of WorldSpace's satellites are expected to be launched in 1998, with service beginning in late 1998 or early 1999. Later, the system may be used for the United States as well. It has little significance for Europe, at least for now.

Mediastar, on the other hand, is intended to provide Europe with satellite radio using DAB, with operation planned to start in 2001 using the 1.5 GHz frequency range. Three low-orbit satellites are planned, to be positioned over the target coverage areas. However, what impact these systems will have on the future of radio is generally unknown.

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Appendix A

Modulation of the RDS Data Signal

A.1 Subcarrier Frequency

The RDS data signal is carried on a subcarrier which is added to the stereo multiplex signal (or monophonic signal as appropriate) at the input to the VHF/FM transmitter. Block diagrams of the data source equipment at the transmitter and a typical receiver arrangement are shown in Figures A.1 and A.2, respectively.

During stereo broadcasts, the subcarrier frequency will be locked to the third harmonic of the 19 kHz pilot-tone. Since the tolerance on the frequency of the 19 kHz pilot-tone is ± 2 Hz (see ITU-R Recommendation BS.450-2), the tolerance on the frequency of the subcarrier during stereo broadcasts is ± 6 Hz.

During monophonic broadcasts, the frequency of the subcarrier will be $57 \text{ kHz} \pm 6 \text{ Hz}$.

A.2 Subcarrier Phase

During stereo broadcasts, the subcarrier will be locked either in phase or in quadrature to the third harmonic of the 19 kHz pilot-tone. The tolerance on this phase angle is $\pm 10^\circ$.

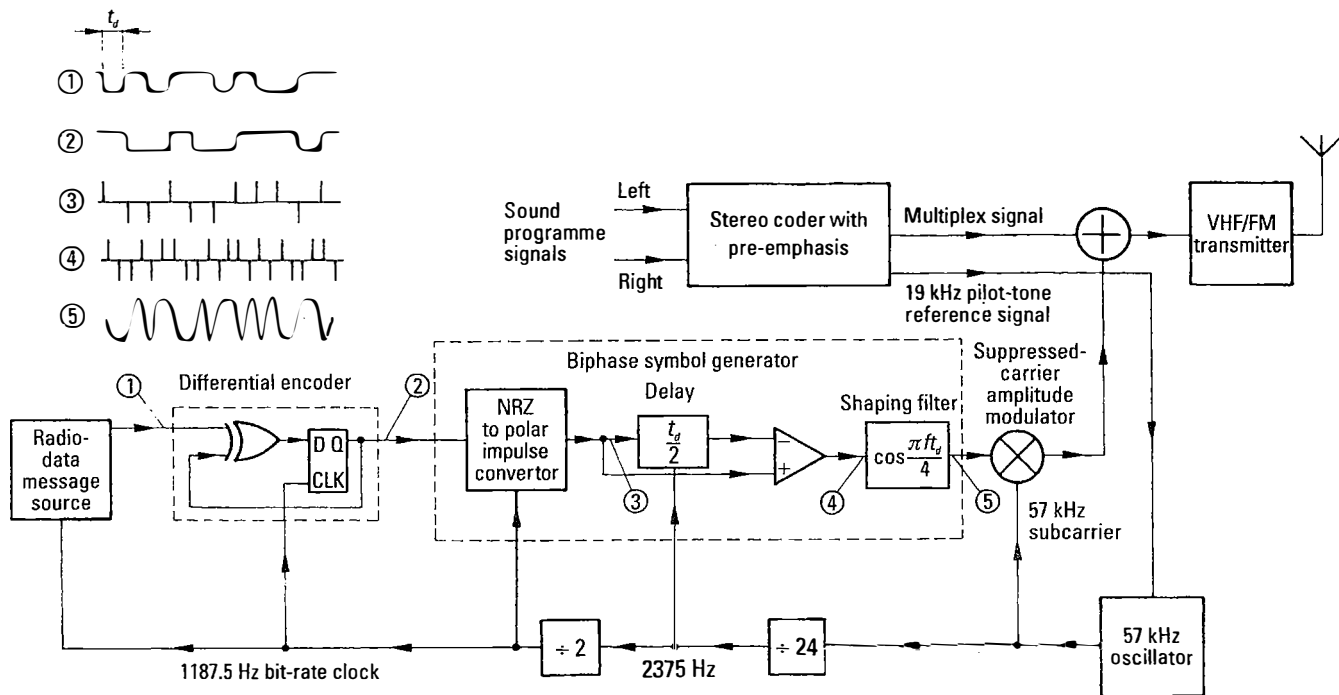


Figure A.1 Block diagram of radio-data equipment at the transmitter. (Source: EBU.)

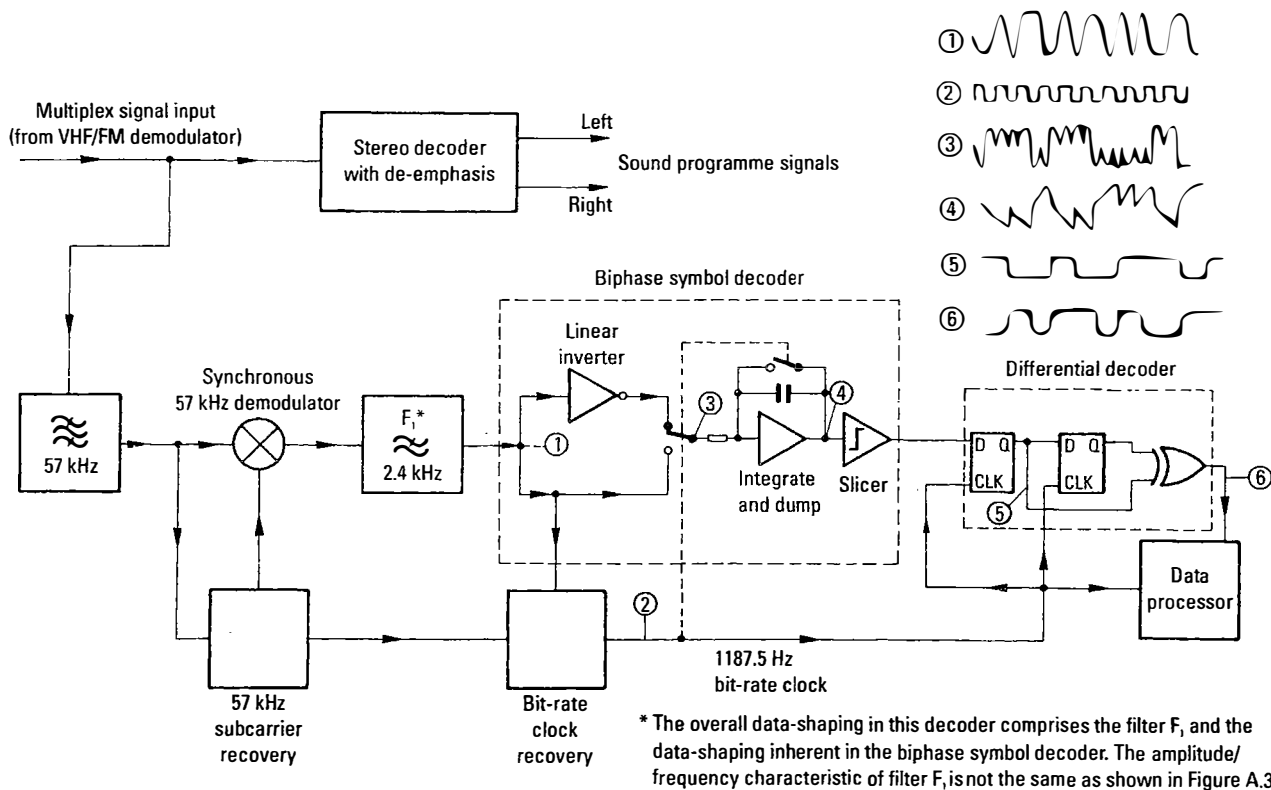


Figure A.2 Block diagram of a typical radio-data receiver/decoder. (Source: EBU.)

A.3 Subcarrier Level

The deviation range of the FM carrier due to the unmodulated subcarrier is from ± 1.0 kHz to ± 7.5 kHz. The recommended best compromise is ± 2.0 kHz.

The decoder/demodulator should also operate properly when the deviation of the subcarrier is varied within these limits during periods not less than 10 ms.

The maximum permitted deviation due to the composite multiplex signal is ± 75 kHz.

A.4 Method of Modulation

The subcarrier is amplitude-modulated by the shaped and biphase coded data signal. The subcarrier is suppressed. This method of modulation may alternatively be thought of as a form of two-phase phase shift keying (PSK) with a phase deviation of $\pm 90^\circ$.

A.5 Clock-Frequency and Data Rate

The basic clock frequency is obtained by dividing the transmitted subcarrier frequency of 57 kHz by 48. Consequently, the basic data rate of the system (see Figure A.1) is 1187.5 bit/s ± 0.125 bit/s.

A.6 Differential Coding

The source data at the transmitter are differentially encoded according to the rules in Table A.1:

where t_i is some arbitrary time and t_{i-1} is the time one message data clock period earlier, and where the message data clock rate is equal to 1187.5 Hz. Thus, when the input data level is 0, the output remains unchanged from the previous output bit. When an input 1 occurs, the new output bit is the complement of the previous output bit.

In the receiver, the data may be decoded by the inverse process (Table A.2):

The data is thus correctly decoded whether or not the demodulated data signal is inverted.

Table A.1
Encoding Rules

Previous Output (at time t_{i-1})	New Input (at time t_i)	New Output (at time t_i)
0	0	0
0	1	1
1	0	1
1	1	0

Table A.2
Decoding Rules

Previous Input (at time t_{i-1})	New Input (at time t_i)	New Output (at time t_i)
0	0	0
0	1	1
1	0	1
1	1	0

A.7 Data Channel Spectrum Shaping

The power of the data signal at and close to the 57 kHz subcarrier is minimized by coding each source data bit as a biphase symbol. This is done to avoid data-modulated cross-talk in phase locked loop stereo decoders, and to achieve compatibility with the ARI system. The principle of the process of generation of the shaped biphase symbols is shown schematically in Figure A.1. In concept, each source bit gives rise to an odd impulse-pair, $e(t)$, such that a logic 1 at source gives:

$$e(t) = \delta(t) - \delta(t - t_d/2) \quad (\text{A.1})$$

and a logic 0 at source gives:

$$e(t) = -\delta(t) + \delta(t - t_d/2) \quad (\text{A.2})$$

These impulse pairs are then shaped by a filter $H_T(f)$, to give the required band-limited spectrum where:

$$H_T(f) = \begin{cases} \cos \frac{\pi f t_d}{4} & \text{if } 0 \leq f \leq 2/t_d \\ 0 & \text{if } f > 2/t_d \end{cases} \quad (\text{A.3})$$

$$t_d = \frac{1}{1187.5} \text{ s}$$

The data-spectrum shaping filtering has been split equally between the transmitter and receiver (to give optimum performance in the presence of random noise) so that, ideally, the data filtering at the receiver should be identical to that of the transmitter, i.e., as given above in Equation A.3. The overall data-channel spectrum shaping $H_0(f)$ would then be 100% cosine roll-off. The specified transmitter and receiver low-pass filter responses, as defined in Equation A.3 are illustrated in Figure A.3, and the overall data-channel spectrum shaping is shown in Figure A.4.

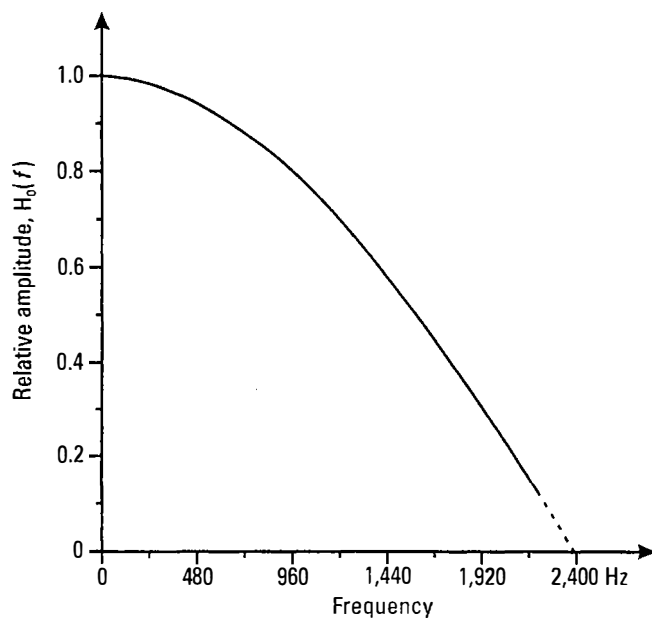


Figure A.3 Amplitude response of the specified transmitter or receiver data-shaping filter. (Source: EBU.)

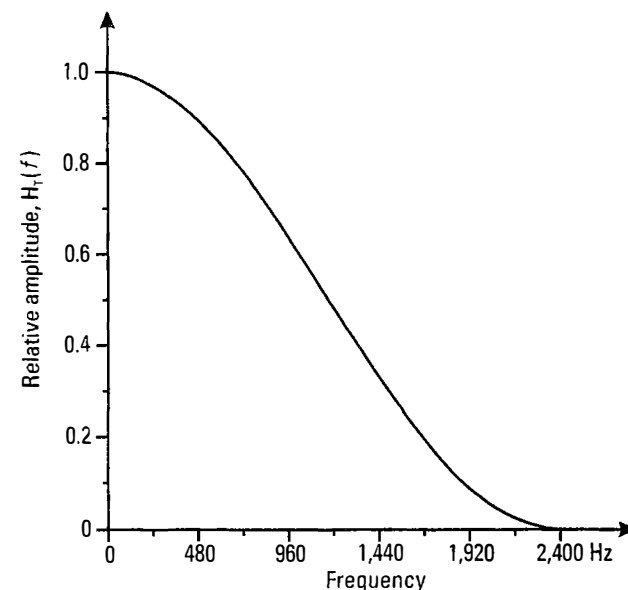


Figure A.4 Amplitude response of the combined transmitter and receiver data-shaping filters. (Source: EBU.)

The spectrum of the transmitted biphase coded radio data signal is shown in Figure A.5 and the time function of a single biphase symbol (as transmitted)

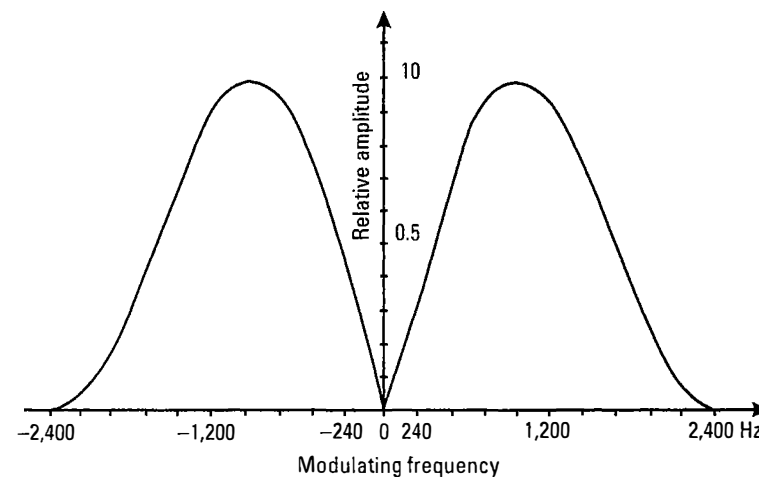


Figure A.5 Spectrum of biphase coded radio data signals. (Source: EBU.)

in Figure A.6. The 57 kHz radio-data signal waveform at the output of the radio-data source equipment may be seen in the photograph of Figure A.7.

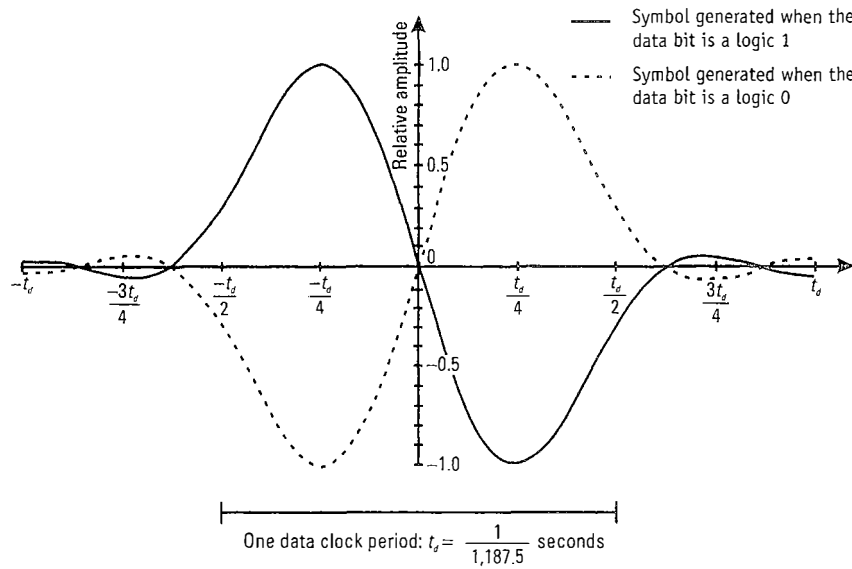


Figure A.6 Time function of a single biphase symbol. (Source: EBU.)

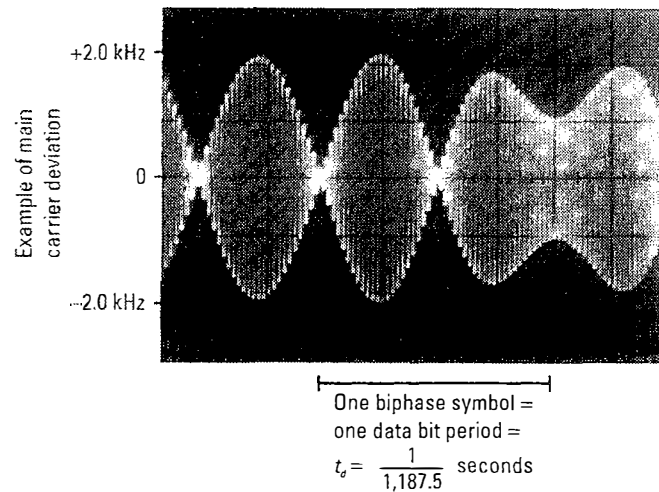


Figure A.7 57 kHz radio data signals. (Source: EBU.)

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Appendix B

RDS Data Decoding

B.1 Introduction

One form of a biphase symbol decoder was shown in Figure A.2 of Appendix A. In that section, it was also explained that the biphase symbol generator produces two impulses for each input bit. The resultant impulse train is the cosine-shaped filtered one, and then modulated on the 57 kHz subcarrier, the basic data rate being 1187.5 bps (i.e., 57 kHz divided by 48, which is the clock frequency). The RDS demodulator/decoder techniques, as well as their functionality and corresponding integrated circuits, were all explained in Chapter 12. In the following section, we deal entirely with decoding the baseband data stream.

B.2 Baseband Coding Structure

Figure B.1 shows the structure of the baseband coding. The largest element in the structure is called a “group” of 104 bits each. Each group is comprised of 4 blocks of 26 bits each. Each block is comprised of an information word and a check word. Each information word is comprised of 16 bits. Each check word is comprised of 10 bits.

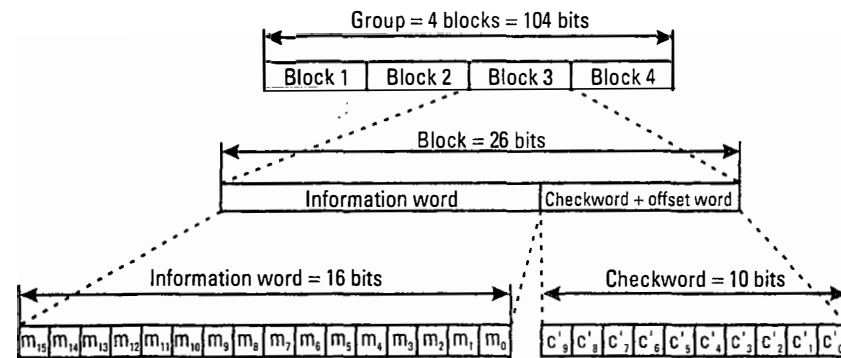


Figure B.1 Structure of the baseband coding. (Source: EBU.)

B.3 Order of Bit Transmission, Error Protection, and Synchronisation Information

All information words, check words, binary numbers, or binary address values have their most significant bit (msb) transmitted first (see Figure B.2). Thus, the last bit transmitted in a binary number or address has weight 2^0 .

The data transmission is fully synchronous, and there are no gaps between the groups or blocks.

Check word + offset word N : 10 bits are added to provide error protection and block and group synchronisation information. Block 1 of any particular group is transmitted first and block 4 last. Each transmitted 26-bit block contains a 10-bit check word that is primarily intended to enable the receiver/decoder to detect and correct errors that occur in transmission. This check word (i.e., $c'_9, c'_8, \dots, c'_0$ in Figure B.1) is the sum (modulo 2) of the following:

- The remainder after multiplication by x^{10} and then division (modulo 2) by the generator polynomial $g(x)$ of the 16-bit information word;
- A 10-bit binary string $d(x)$, called the "offset word," where the values are different for each block within a group (see Figure B.2 and Table B.1).

The above is true where the generator polynomial, $g(x)$ is given by

$$g(x) = x^{10} + x^8 + x^7 + x^5 + x^4 + x^3 + 1$$

Table B.1
Binary Values of the RDS Offset Words

Offset Word	Binary Value									
	d_9	d_8	d_7	d_6	d_5	d_4	d_3	d_2	d_1	d_0
A	0	0	1	1	1	1	1	1	0	0
B	0	1	1	0	0	1	1	0	0	0
C	0	1	0	1	1	0	1	0	0	0
C'	1	1	0	1	0	1	0	0	0	0
D	0	1	1	0	1	1	0	1	0	0
E	0	0	0	0	0	0	0	0	0	0

The offset words are chosen in such a way that the content in the offset register will not be interpreted as a burst of errors equal to or shorter than five bits when rotated in the polynomial shift register.

Only eight bits (i.e., d_9 to d_2) are used for identifying the offset words. The remaining two bits (i.e., d_1 and d_0) are set to logical level zero.

The five offset words A, B, C, C', and D of Table B.1 are used for all applications, except that offset word E is used in multiples of four blocks when RDS and MMBS are simultaneously implemented in the United States. Offset word E must not be used in RDS implementations outside the United States, but receivers should generally be designed to recognise offset word E and not be desynchronised when it occurs in multiples of 4.

The offset words are added (modulo 2) to the check word $c_9 - c_0$ to generate the modified check-bits: $c'_9 - c'_0$.

The purpose of adding the offset word is to provide a group and block synchronisation system in the receiver/decoder. Because the addition of the offset is reversible in the decoder, the normal additive error-correcting and detecting properties of the basic CRC code are unaffected.

The check word thus generated is transmitted msb (i.e., the coefficient of c'_9 in the check word) first and is transmitted at the end of the block that it protects.

The error-protecting code has the following error-checking capabilities:

- Detects all single and double bit errors in a block;
- Detects any single error burst spanning 10 bits or less;

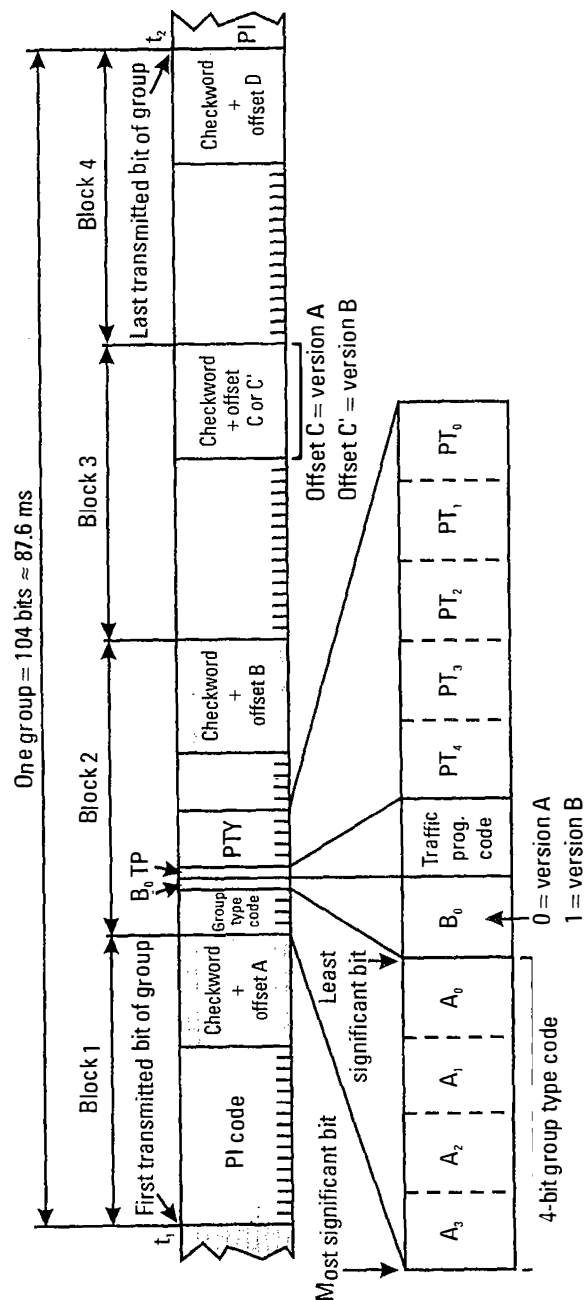


Figure B.2 Message format and addressing. (Source: EBU.)

- Detects about 99.8% of bursts spanning 11 bits and about 99.9% of all longer bursts.

The code is also an optimal burst error-correcting code and is capable of correcting any single burst of a span of five bits or less.

The blocks within each group are identified by the offset words A, B, C (or C' instead of C), and D added to blocks 1, 2, 3, and 4, respectively, in each type A (or, with offset C', type B) group.

The beginnings and ends of the data blocks may be recognised in the receiver decoder by using the fact that the error-checking decoder will, with a high level of confidence, detect block synchronisation slip as well as additive errors. This system of block synchronisation is made reliable by the addition of the offset words (which also serve to identify the blocks within the group). These offset words destroy the cyclic property of the basic code so that in the modified code, cyclic shifts of code words do not give rise to other code words.

B.4 Message Format and Addressing of Groups

The basic design principles underlying the message format and addressing structure are as follows:

- The messages that are to be repeated most frequently, and for which a short acquisition time is required (i.e., PI, PTY and TP codes, as well as the group type code) occupy the same fixed positions within every group. They can therefore be decoded without reference to any *block* outside the one that contains the information.
- There is no fixed rhythm of repetition of the various types of group; that is, there is ample flexibility to interleave the various kinds of messages to suit the needs of the transmission operator at any given time, and to allow for future developments.
- This requires addressing to identify the information content of those blocks that are not dedicated to the high-repetition-rate information.
- Each group is, so far as possible, fully addressed to identify the information content of the various blocks.
- The mixture of different kinds of messages within any one group is minimised; for example, one group type is reserved for basic tuning information, another for RadioText, and so on. This is important so that broadcasters who do not wish to transmit certain kinds of

messages are not forced to waste channel capacity by transmitting groups with unused blocks. Instead, they are able to repeat more frequently those group types that contain the messages they want to transmit.

- To allow for future applications, the data formatting has been made flexible. For example, the ODA feature (see Chapter 9) may be used for the definition of any (public domain or proprietary) future application.

The main features of the message structure have been illustrated in Figure B.2. These may be seen to be as follows:

1. The first block in every group always contains a PI code.
2. The first four bits of the second block of every group are allocated to a four-bit code that specifies the application of the group (group type number address). Groups will be referred to as type number 0 to 15 according to the binary weighting $A_3 = 8$, $A_2 = 4$, $A_1 = 2$, $A_0 = 1$ (see Figure B.2). For each type (0 to 15), one of two versions, A or B, can be defined. The version is specified by the fifth bit (B_0) of block 2 as follows:
 - a. $B_0 = 0$ (type A versions; e.g., 0A, 1A, etc.): the PI code is inserted in block 1 only.
 - b. $B_0 = 1$ (type B versions; e.g., 0B, 1B, etc.): the PI code is inserted in block 1 and block 3 of all group types.

In general, any mixture of type A and B groups is transmitted.

3. The PTY and TP identification occupy fixed locations in block 2 of every group.

As already stated above, the PI, PTY, and TP codes can be decoded without reference to any block outside the one that contains the information. This is essential to minimise acquisition time for these kinds of messages and to retain the advantages of the short (26-bit) block length. To permit this to be done for the PI codes in block 3 of version B groups, a special offset word (which is called C') is used in block 3 of version B groups. The occurrence of offset C' in block 3 of any group can then be used to indicate directly that block 3 is a PI code, without any reference to the value of B_0 in block 2.

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Appendix C

RDS Reception Reliability

C.1 Introduction

Field tests carried out by a number of broadcasters' research laboratories all came to the same conclusions [1-3].

Relatively low RDS data injection levels, say ± 1 kHz deviation, offer a reliable data system, but only under receiving conditions with little or no multipath effects (e.g., in open, relatively flat country with good line of sight from the transmitter). Multipath effects occur due to reflections of the transmitted signal by high-rise buildings or in mountainous terrain. In a moving receiver, once multipath effects occur, there is a sharp decrease in reception reliability. However, reliability can be increased by data repetition because multipath reception has the effect of reducing reception performance for fractions of a second as the receiver moves from good to poor to good reception locations.

C.2 Bit Error Rate

Curve (a) in Figure C.1 shows the bit error rate of the experimental reference RDS demodulator measured as a function of the power applied at the aerial input of the VHF/FM receiver. The VHF/FM receiver used in these measurements had a noise figure of 5.5 dB. For the purposes of comparison, the theoretical bit error rate expected according to theory is given as curve (b). It may be

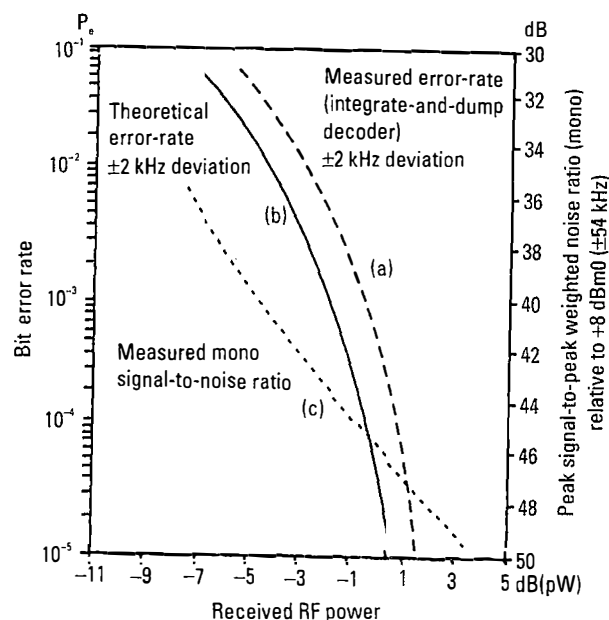


Figure C.1 Bit error rate of the reference RDS demodulator (theoretical and measured results): receiver noise figure = 5.5 dB. (Source: BBC/EBU.)

seen that the measured performance of this experimental RDS decoder is within about 1 dB of that expected from theory.

Note that the deviation due to the RDS signal was ± 2 kHz. For other deviations, the results may be linearly scaled. For example, for ± 1.2 kHz deviation, the RF input power needed to attain a given bit error rate would be about 4.4 dB (i.e., $20 \log(2/1.2)$) greater.

Curves (a) and (b) in Figure C.1 illustrate the rapid failure with the typical declining signal-to-noise ratio characteristic of most digital systems. For satisfactory operation, the RDS system needs a bit error rate better than about 2×10^{-2} .

Also shown in Figure C.1, as curve (c), is the mono peak signal-to-peak weighted noise ratio (measured according to ITU-R Recommendation BS.468-4) obtained in the sound programme channel of the same VHF/FM receiver used in the error rate measurements of curve (a). This was measured after 50 μ s de-emphasis relative to a +8 dBm tone at 440 Hz (i.e., 54 kHz deviation with standard BBC line-up levels). Stereo reception would, in theory at least, need 20 dB more RF power to achieve the same signal-to-noise ratio as that shown for mono.

Thus, it is found that when the only impairment to reception is random noise due to low field-strength, the RDS system operates satisfactorily until beyond the point at which stereo reception of the programme signal becomes unusable. At the field-strength corresponding to the failure point of the RDS system, mono reception is noisy but still intelligible and remains so for aerial input levels down to about -10 dB(pW). In practice, this is not a problem because such low field-strengths usually occur only well outside the service area of the transmitter, and it is often possible to switch to an alternative frequency carrying the same service. Furthermore, where such low field-strengths prevail, there are usually other impairments to reception, such as multipath, which render the programme signal unusable.

C.3 Block Error Rate

It is important to remember that because of the use of differential decoding in the RDS demodulator, the errors usually occur in bursts spanning two bits. Single errors occur only when adjacent bits in the received data stream, before differential decoding, are in error.

In the RDS system, the block length for the purpose of error protection is 26 bits. Curves showing the probability of correct reception of PI codes (which are equivalent to one RDS block) are given in Figure C.2, where the only impairment to reception is random noise due to low field strength and is plotted as a function of RF input power to the aerial input of the VHF/FM receiver. Curves (4) and (3) show the results with and without error correction, respectively, for ± 2 kHz deviation; curves (2) and (1) show the corresponding results for ± 1.2 kHz deviation. The error correction used in obtaining the results shown in curves (4) and (2) accorded with that recommended in the RDS/RBDS standards; that is, bursts of errors spanning only up to two bits in a block were corrected—longer bursts were detected and those blocks were rejected.

Comparing curves (3) and (4) with curves (2) and (1), it may be seen that under conditions where the received signal is impaired by low field-strength only, the use of error correction yields a maximum improvement equivalent to less than 2 dB in RF level. However, as will be shown, error correction yields a greater improvement with the burst errors characteristic of mobile reception.

C.4 Error Rates for RDS Messages

As was noted above, the probability of correct reception of a PI code is simply the probability of reception of an RDS block, as shown by the curves in

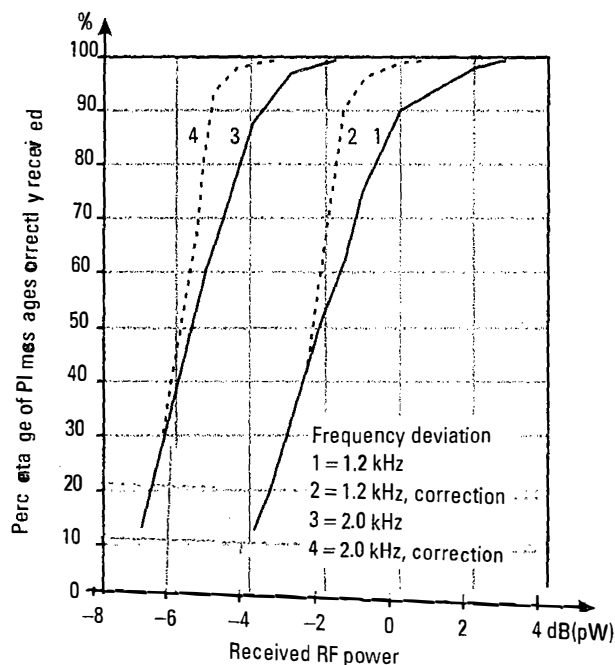


Figure C.2 Influence of the RF level, error correction, and frequency deviation on the broadcast reliability. (Source: IRT/EBU.)

Figure C.2. The same is also true for all other kinds of messages that occupy fixed positions within *all* RDS group types and can therefore be decoded without reference to any information outside the block that contains them. Included in this category are PI, PTY, and TP identification.

Other messages require correct decoding of the group type address, and perhaps other information such as the segment address for PS codes. Inevitably, the more RDS blocks that a message and its related addressing occupy, the lower the probability of correct reception of the complete message. However, in most applications needing long messages (e.g., RadioText), it is not necessary to receive the whole message correctly before making use of it; missing or erroneous characters can easily be tolerated on displayed messages.

Curves showing the probability of correct reception of PI, PS, and RT messages when the only impairment to reception is random noise due to low field-strength are given in Figure C.3. The deviation due to the RDS signal was ± 2 kHz, and two-bit burst error correction was applied.

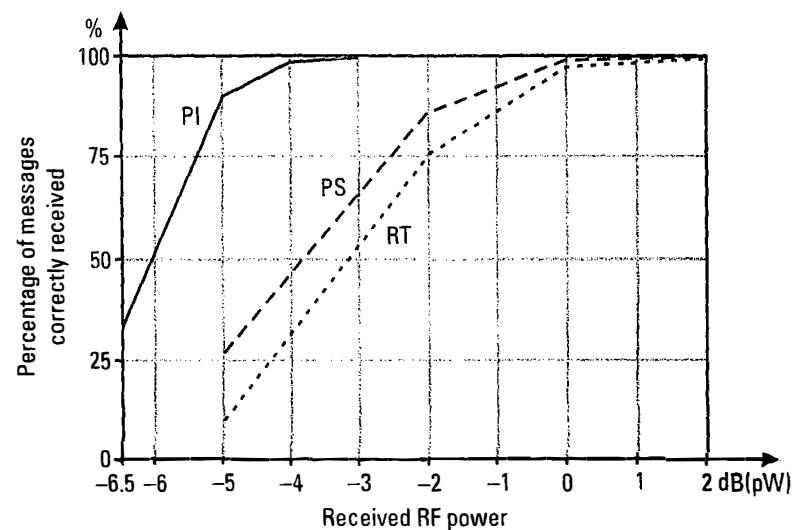


Figure C.3 Reliability of reception of RDS messages. (Source: IRT/EBU.)

C.5 RDS Coverage Area

In a study carried out by the IRT in Germany [3] for PI (corresponding to block error rate) and PS features, and for various reception conditions, the relation between RDS frequency deviation and coverage area was determined using frequency deviations of ± 1.2 kHz, ± 1.5 kHz, and ± 2.0 kHz.

The total of all areas with transmission reliability equal to or greater than 90% was designated as the RDS coverage area in this study. To avoid time-consuming field measurements, the experiments were performed with a radio channel simulator.

The study came to the following conclusions.

In unfavourable reception conditions, transmission reliability and thus coverage area can be increased by raising the RDS frequency deviation. The increase in coverage area is directly dependent on the reception conditions prevailing in that area. In unfavourable reception conditions, the coverage area can be distinctly enlarged with an increase in RDS frequency deviation higher than ± 1.5 kHz.

Simultaneous transmission of ARI reduces the coverage area. Services requiring relatively brief access times should therefore not be installed on ARI networks.

The use of error correction does not significantly enlarge the coverage area. In unfavourable reception conditions, the use of error correction can, however, definitely improve transmission reliability. Especially in a stationary vehicle (e.g., at traffic lights), RDS reception of dynamic information items (e.g., RadioText) is possible only through error correction.

The improved transmission reliability with an increased RDS frequency deviation can determine whether or not an RDS transmitter is accepted by the receiver. There are, for example, receivers that locate RDS traffic information service transmitters by scanning the entire VHF/FM Band II and store or attach to station selector buttons according to an internal quality code a defined number of the transmitters detected (RF signal level, reception interference, block error rate). In this process, transmitters that can be received with a low block error rate take precedence.

RDS services—such as Radio Paging, TMC, DGPS, and also EWS—require short access times and a large RDS coverage area. Since the total capacity of approximately 11.4 groups per second does not permit frequent repetition of these dynamic information items, these requirements can be met only through a higher RDS frequency deviation and the resulting improvement in transmission reliability.

References

- [1] Mielke, J., and K. H. Schwaiger, "Progress with the RDS system and experimental results," *EBU Review-Technical*, No. 217, June 1986.
- [2] Lyner, A. G., Experimental Radio Data System (RDS): A survey of reception reliability in the UK, BBC Research Department, Report No. 1987/17.
- [3] Schwaiger K. H., The RDS coverage area in relation to the RDS frequency deviation, Technical Report B 148/95, Institut für Rundfunktechnik München, 1995.

Appendix D Required Data Repetition Rates for Programme-Related RDS Features

The mixture of different kinds of messages within any one group is minimised; for example, one group type is reserved for basic tuning information, another for RadioText, and so on. This is important so that broadcasters that do not wish to transmit messages of certain kinds are not forced to waste channel capacity by transmitting groups with unused blocks. Instead, they are able to repeat more frequently those group types that contain the messages they want to transmit. There is no fixed rhythm of repetition of the various types of group; that is, there is ample flexibility to interleave the various kinds of messages to suit the needs of the users at any given time and to allow for future developments.

A total of four type 0A groups are required to transmit the entire PS name and therefore four type 0A groups will be required per second. The repetition rate of the type 0A group may be reduced if more capacity is needed for other applications (see Table D.1). However, with EON receivers, search tuning is affected by the repetition rate of type 0 groups. A minimum of two type 0A groups per second is necessary to ensure correct functioning of PS and AF features. It should be noted that in this case, transmission of the complete PS will take two seconds. However, under typical reception conditions, the introduction of errors will cause the receiver to take four seconds or more to acquire the PS name for display.

Table D.1

Recommended Repetition Rates for the Programme Related Features

Main Features	Group Types That Contain This Information	Appropriate Repetition Rate Per Second
Programme Identification (PI) code	All	11.4 ¹⁾
Programme Type (PTY) code	All	11.4 ¹⁾
Traffic Programme (TP) identification code	All	11.4 ¹⁾
Programme Service (PS) name ⁴⁾	0A, 0B	1
Alternative Frequency (AF) code pairs	0A	4
Traffic Announcement (TA) code	0A, 0B, 15B	4
Decoder Identification (DI) code	0A, 0B, 15B	1
Music Speech (MS) code	0A, 0B, 15B	0.2 ²⁾
RadioText (RT) message	2A, 2B	Up to 2 ³⁾
Enhanced Other Networks (EON) information	14A, 14B	

1) Valid codes for this item will normally be transmitted with at least this repetition rate whenever the transmitter carries a normal broadcast programme.

2) A total of 16 type 2A groups are required to transmit a 64-character RT message and therefore 3.2 type 2A groups will be required per second.

3) The maximum cycle time for the transmission of *all* data relating to *all* cross-referenced PSs shall be less than two minutes.

4) PS must only be used for identifying the PS, and it must not be used for other messages giving sequential information.

When the PIN or slow-labelling is implemented, type 1 groups should be used once per minute, but when the PIN is changed, a type 1 group should be repeated four times with a separation of about 0.5 seconds. Where RP is implemented in RDS, a type 1A group will be transmitted in an invariable sequence, regularly once per second, except at each full minute, where it is replaced by one type 4A group.

The mixture of groups shown in Table D.2 is suitable to meet the repetition rates noted above.

Table D.2

Group Repetition Rates

Group Types	Features	Typical Proportion of Groups of This Type Transmitted
0A or 0B	PI, PS, PTY, TP, AF ¹⁾ , TA, DI, M/S	40%
1A or 1B	PI, PTY, TP, PIN	10%
2A or 2B	PI, PTY, TP, RT	15% ²⁾
14A or 14B	PI, PTY, TP, EON	10%
Any other	Other applications	25%

1) Type 0A group only.

2) Assuming that type 2A groups are used to transmit a 32-character RadioText message. A mixture of type 2A and 2B groups in any given message should be avoided.

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.

Appendix E

RDS Data Transmission Capacity Limits

E.1 Introduction

The use of the features to achieve automated tuning, essentially for mobile reception, requires a considerable part of the channel capacity. An RDS uses a data stream of 1187.5 bps and offers a choice of some 20 well-defined features. The data capacity is not large enough to allow all these features to be implemented in the same channel, as shown in the following analysis.

E.2 Calculation of RDS Capacity

The bit rate of 1187.5 bps of the RDS is fairly low and therefore the RDS channel capacity is a rather limited resource. Bearing in mind that the four check words in each group of 104 bits occupy a total of 40 bits, and that each group address needs 5 bits, one arrives at a *useful* bit rate of

$$1187.5 - (1187.5/104) \times (40 + 5) = 673.7 \text{ bps}$$

E.3 Analysis of RDS Capacity

E.3.1 Grouping of Different Features

In order to analyse the usage of RDS capacity for each of the features, they are grouped together in categories according to their impact on the RDS channel capacity. Firstly, the capacity required for all the broadcasting programme-related features is examined and then what is left over for the nonprogramme-related features can be identified.

As is shown in Table E.1, the programme-related features can be divided into four categories:

- The five primary features—AF, PI, PS, and TP/TA—mainly required for the automated tuning process;
- The EON information, which really is a complementary feature for automated tuning as far as networks are concerned;
- A group of features—CT, DI, MS, PIN, PTY, and PTYI—requiring relatively little RDS capacity to be implemented. Note that PIN only requires a repetition rate of one group type 1A per minute; however, in connection with RP it must be increased to one per second.
- RadioText.

Furthermore, in Table E.1 the nonprogramme-related features—IH, RP, TDC, and TMC—are identified.

E.3.2 Discussion on the Analysis

The following can be seen from Table E.1:

- *AF, PI, PS, TP/TA*: These primary functions of RDS, essentially supporting the automated tuning process, require already 48.35% of the available channel capacity.
- *EON*: If the automated tuning process were to be enhanced by broadcasters operating networks through the use of the EON feature, 8.24% of the capacity would have to be set aside, bringing the total up to 56.59%.
- *PTY, MS, DI, PIN, CT*: All these features require relatively little RDS capacity. While the first three require 9.65% whether implemented or not, for reasons of coding, the latter two add an additional 0.21%

Table E.1
Analysis of the Required RDS Capacity

Analysis of the required RDS capacity

Application	Feature	Group Types Containing this Information	Appropriate Minimum Group Repetition Rate per Second	Number of Occupied Bits per Group	Number of Occupied Bits per Second	Percent of 673.7 Bits per Second	Accumulated RDS Capacity
Automated tuning	PI	All	11.4	16	182.4	27.07	48.35
	PS	0A	4.0	16	64.0	9.50	
	AF	0A	4.0	16	64.0	9.50	
	TP	all	11.4	1	11.4	1.69	
	TA	0A	4.0	1	4.0	0.59	
Enhanced information on other networks	EON	14A(B)	1.5	37	55.5	8.24	56.59
Various other programme-related features	PTY	All	11.4	5	57.0	8.46	66.44/71.83*
	MS	0A	4.0	1	4.0	0.59	
	DI	0A	4.0	1	4.0	0.59	
	PIN	1A(B)	0.02/1.0* 37**	0.74/37*	0.11/5.5*	0.10	
	CT	4A	0.02	34	0.68		

Table E1 (continued)

Application	Feature	Group Types Containing this Information	Appropriate Minimum Group Repetition Rate per Second	Number of Occupied Bits per Group	Number of Occupied Bits per Second	Percent of 67.37 Bits per Second	Accumulated RDS Capacity
RadioText	RT	2A(B)	32***	37	118.4	17.58	$\frac{4}{8} 89.41^*$
Various nonprogramme-related features	RP TDC IH TMC	1A/4A/7A/13A 5A(B) 6A(B) 3A/8A					

* If Radio Paging is used, an increase in repetition rate of 1 per second is necessary.

** Although 6 bits are actually used for PIN, the associated 6 undefined and 5 spare bits must also be taken into account since this represents used capacity.

*** To agree with Note 2 in Table 4 of CENEL E EN 50 067: 998, Section 3.13: A total of 16 type 2A groups are required to transmit a 64 character RadioText message, and there are 16 groups in 5 seconds, 3.2 type 2A groups will be required per second.

The appropriate minimum repetition rate is specified in the RDS and RDS standards and is detailed in Appendix D herein.

(5.6% if RP is implemented), bringing the total required to 66.44% (or 71.83% with RP).

- RT: RadioText requires an additional 17.58%, bringing the total required for the programme-related features up to 84% (or 89.41% with RP).

This then leaves 16% (10% with RP), for the implementation of the nonprogramme-related features (IH, ODA, TDC, and TMC); that is, 108 bps (or 68 bps with RP). Each of them will require, if implemented, a significant proportion of the remainder. In fact, in the case of Radio Paging, the paging traffic is likely to account for the balance of the capacity remaining.

Type A groups, for example, can carry in ODA only up to 37 application bits, which means that there will only be capacity left for two to three groups per second. This makes the dilemma of the very restricted data capacity in RDS for other than radio programme-related applications very obvious.

However, due to the time-multiplexing possibilities of many of these features, the average capacity available for other features will be greater than this indicated "peak demand," since it is unlikely, for example, that continuous RadioText will be a requirement.

E.4 Conclusion About RDS Capacity

This form of analysis makes it quite clear that, from the broadcasters' point of view, it seems advisable to set aside about 80% of the RDS channel capacity for the implementation of all programme-related features. This leaves about one-fifth of the channel capacity to accommodate features unrelated to the radiated programmes. This implies that only a limited number of further applications can actually be implemented within any specific programme service. Due consideration must therefore be given to how IH, ODA, RP, TDC, and TMC can be distributed among different programme networks; for example, a network that carries TP/TA could only accommodate in addition, say, TMC. The same is also true with respect to so far unknown applications (e.g., those that can be implemented through ODA); their required capacity has to be carefully examined before any decision can be taken as to the possibility of their implementation.

In conclusion, RDS has a finite capacity—it is not an inexhaustible resource. That is a fundamental reality that it shares with any other communication channel, including, of course, the VHF/FM broadcast channels that RDS exploits and serves.

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, Guidelines for the implementation of the RDS system, Tech. 3260-E, Jan. 1990.

Appendix F

PI Coding in RDS and RBDS

F.1 Introduction

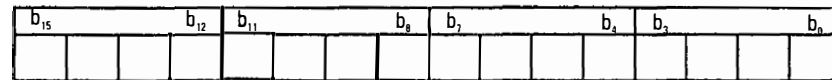
PI codes are the key to the automatic tuning and follow-me features of a RDS. They act as “digital signatures” to prevent false switching between stations carrying different programme signals (but perhaps sharing alternate frequencies). Care must be taken, therefore, in the region of borders between different countries, to avoid two stations having the same PI code that are both receivable at the same location.

Codes shall be assigned in each country in such a way that automatic search tuning to other transmitters radiating the same programme can locate the same PI code; that is, all 16 bits shall be identical. In cases where during a few programme hours, a network is split to radiate different programmes, each of these programmes shall carry a different PI code, by using different coverage-area codes.

PI codes in North America are issued and utilised differently than in the rest of the world. The particular principles used are explained in Section F.3.

F.2 Programme Identification Code Structure

The PI code consists of 16 bits and is usually referred to by four hexadecimal characters, or nibbles. See Figure F.1 for an example.



Bits b_{15} to b_{12} (first nibble): Country identification (Codes are given in Appendix G)

Bits b_{11} to b_8 (second nibble): Programme Type in terms of area coverage

Bits b_7 to b_0 (third and fourth nibbles): Programme reference number

General remark: All codes are binary-coded hex numbers

Figure F.1 PI code structure. (Source: EBU.)

Code assignments for bits b_{11} to b_0 should be decided by relevant authorities in each country individually.

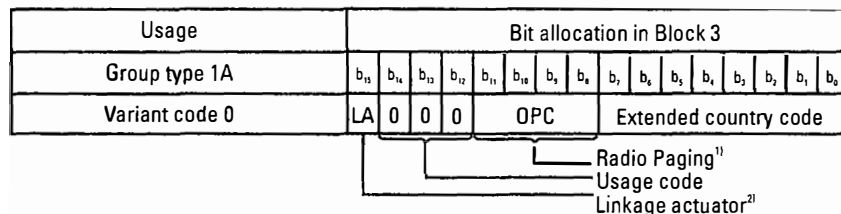
F.2.1 Country Identification

Extended Country Codes shall be transmitted in type 1A groups to render the country code in bits b_{15} to b_{12} of the PI code *unique*. The ECC is carried in variant 0 of block 3 of type 1A groups and consists of eight bits. This variant should be transmitted at least once every minute.

The bit allocation of the Extended Country Codes is given in Figure F.2, and the codes are given in Appendix G.

F.2.2 Coverage Area Codes

The second nibble is allocated according to the coverage area of the service. Code 0 hex indicates a local service broadcast from a single transmitter only,



1. The operator code for Radio Paging using the Enhanced Paging Protocol is defined in Appendix M of the RDS/RBDS standards.

2. The linkage actuator is defined in the method for linking RDS programme services (see the RDS/RBDS standards).

Figure F.2 Structure of variant 0 of block 3 of type 1A groups (Extended Country Codes). (Source: EBU.)

code 1 indicates a service available internationally, code 2 hex, a national service, and code 3 hex, a service covering a national region or other major area within a country code area. Codes 4-F hex are used for regional services.

Hex-coding rules for bits b_{11} to b_8 are given in Figure F.3.

F.2.3 Programme Reference Number

Hex coding for bits b_7 to b_0 are given in Table F.1.

Example: Decimal number 148 corresponds to hexadecimal-code 94—this is just a straight dec to hex conversion.

In order to clearly identify the different programme families, these codes should, in each country, be systematically assigned and generically linked to the programme families.

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 F.3 Coverage area hex codes used in the second nibble (bits b_{11} to b_8) of the PI code. (Source: EBU.)

Table F.1

Bits b_7 to b_0

Decimal Numbers	Hex	
00	00	Not assigned
01 to 255	01 to FF	Programme reference number

F.3 PI Coding Rules for North America

F.3.1 Basic Principles

In North America (United States, Canada, and Mexico), PI codes are based on call letters rather than being assigned by any national organisation, as is done in countries throughout the rest of the world. A portion of the PI codes are reserved for network usage and also for assignment to stations in Canada and Mexico.

The CENELEC RDS standard accepts the usage of coverage area codes for all possible PI codes (see Section F.2 above on coverage area codes). Within North America coverage, area codes are only recognised in the following range of PI codes:

- B_01 to B_FF hex
- D_01 to D_FF hex
- E_01 to E_FF hex

All other PI codes do not make use of coverage area codes and must be handled as such within the receiver.

Some current European receivers store PI codes into presets in addition to storing frequencies into presets. This function is to recognise the broadcast first by programme rather than frequency. Thus, if a preset is pushed and the PI code has changed, the European RDS receivers would not recognise the new PI code and go into a PI search.

A technical publication from the EBU states:

If, however, the PI code changes completely, the receiver should initiate a PI search for a frequency whose PI code exactly matches the PI code of the original tuned frequency. Failing an exact PI code match, the receiver should search for a PI code differing only in the regional element (b_{11} to b_8) from the original PI code. If neither of these criterion are met, the receiver should remain on the original tuned frequency.

Therefore, since call letters are used to create the PI code, the receiver would have to do a PI search every time a station would change call letters or a preset is pushed in a new listening area having a station at the same frequency as

the preset station. For PI codes smaller than B000 hex, future receivers could check the AF list associated with a preset and if no AFs are acceptable, a PI search could be initiated. If no identical PI is found, the receiver should return to the original tuned frequency and accept the new PI code.

If a PI search is performed, the regional variant search (the second search to match PI codes, differing only in b_{11} to b_8) should be eliminated in a PI search if the tuned PI is below B000 hex, or within the ranges of C001 to CFFF hex and F001 to FFFF hex.

If a feature similar to European regional variants is desired, a grouping in the B, D, and E blocks could be designated as follows. If NPR broadcasts break off national programming to go local for a period of time, it could be assigned a PI of B_01. Note that you cannot use 0 as the second nibble because current receivers will not search for AFs. Therefore, use 1–8 to F for indication of a “regional” variant. If no AFs or identical PIs are found via the AF list or an identical PI search, the receiver could, while tuned to NPR station 1 (PI = B101) accept a variant NPR station 2 whose PI varies only in the second nibble (bits 5–8). Thus B201, B301, B401, ... could be accepted.

PI codes starting with the B, D, and E nibbles yield 765 possibilities for “regional” programming. These PI codes will be shared by the United States, Canada, and Mexico. The problem here becomes that a “telephone book” needs to be kept; however, there should not be too many broadcasts that fit in this category and not many would be used.

F.3.2 Call Letter Conversion Method

The call letter conversion method to be used is described in detail in the RBDS standard, Annex D, Section 6.1. It makes use of a conversion table and some simple algorithms. The details required to make the conversion are, however, so extensive that they cannot be quoted in this book, and only the RBDS standard itself can help here in proceeding with the conversion of a particular case.

The rules that are spelled out in the RBDS standard could also be implemented in encoder software so that the station that wants to use RDS can simply enter its call letters and subsequently the encoder would then make the PI code assignment in full compliance with these rules. The broadcast station interested in this matter should discuss this issue with the encoder supplier to avoid any error or misunderstanding.

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] EIA/NAB(1997), National Radio Systems Committee: United States RBDS Standard version 2.0, Specification of the Radio Broadcast Data System (RBDS).
- [3] EBU, Guidelines for the implementation of the RDS system, Tech. 3260-E, Jan. 1990.

Appendix G

RDS Country or Area Identification Codes

G.1 Introduction

This appendix lists the RDS country or area identification codes as they are allocated in the RDS/RBDS standards [1, 2]. Although these standards were developed for Europe and North America only, the continued development of RDS worldwide made it necessary to allocate in the RDS/RBDS standards PI country/area identification symbols throughout the world.

The PI code is used in each RDS group, always in the first block of type A and B groups; for type B groups, the PI code is repeated in the third block. Details of the PI code usage are given in Chapter 3 and Appendix F.

The country/area code is a hex code symbol that occupies the first four bits of the PI code. Only 15 different symbols exist, and they are repetitively assigned to countries in such a way that broadcasts of the one country/area sharing the same symbol cannot be received in the other country/area. However, a unique identification of any country/area sharing the country/area symbol with other countries/areas is possible if the optional ECC has also been implemented.

It should also be noted that certain countries use more than one country/area symbol. Germany, for example, has two symbols for historical reasons, since the respective codes were allocated before the reunification. Before, one code was for Eastern Germany and the other for Western Germany, but now no distinction is being made and both codes may be used all over Germany. In the United States, Canada, and Mexico, a range of country/area codes is used to

permit application of a formula for the automatic conversion of call letters into the PI code to avoid the need for any centralised PI administration in these countries.

G.2 PI Code Structure

The Programme Identification code consists of 16 bits. Bits b_{15} to b_{12} make up the country/area symbol (hex code) as defined in Section 4. Code assignments b_{11} to b_0 should be assigned by relevant authorities in each country or area in such a way, for example, that bits b_{11} to b_8 describe the Programme TYPe in terms of area coverage, and bits b_7 to b_0 are a programme reference number.

Codes shall always be assigned in such a way that automatic search tuning to other transmitters radiating the same programme can locate the same Programme Identification Code; that is, all 16 bits shall be identical.

G.3 Extended Country Codes

ECC shall be transmitted in type 1A groups (the last eight bits in Block 3 of Variant 0) to render the country/area code in bits 1 to 4 of the PI code unique.

G.4 Allocated Country/Area Symbols

G.4.1 Allocation of Symbols for Countries in ITU Region 1

G.4.1.1 European Broadcasting Area

Table G.1 lists the PI and ECC symbols for European countries.

Table G.1
European Codes

Country/Area	ISO Code	Symbol for PI (Hex)	ECC (Hex)
Albania	AL	9	E0
Algeria	DZ	2	E0
Andorra	AD	3	E0

Table G.1 (continued)

Country/Area	ISO Code	Symbol for PI (Hex)	ECC (Hex)
Austria	AT	A	E0
Azores [Portugal]	PT	8	E4
Belgium	BE	6	E0
Belarus	BY	F	E3
Bosnia-Herzegovina	BA	F	E4
Bulgaria	BG	8	E1
Canaries [Spain]	ES	E	E2
Croatia	HR	C	E3
Cyprus	CY	2	E1
Czech Republic	CZ	2	E2
Denmark	DK	9	E1
Egypt	EG	F	E0
Estonia	EE	2	E4
Faroe Islands [Denmark]	DK	9	E1
Finland	FI	6	E1
France	FR	F	E1
Germany	DE	D or 1	E0
Gibraltar [United Kingdom]	GI	A	E1
Greece	GR	1	E1
Hungary	HU	B	E0
Iceland	IS	A	E2
Iraq	IQ	B	E1
Ireland	IE	2	E3
Israel	IL	4	E0
Italy	IT	5	E0
Jordan	JO	5	E1
Latvia	LV	9	E3
Lebanon	LB	A	E3
Libya	LY	D	E1
Liechtenstein	LI	9	E2
Lithuania	LT	C	E2
Luxembourg	LU	7	E1

Table G.1 (continued)

Country/Area	ISO Code	Symbol for PI (Hex)	ECC (Hex)
Macedonia	MK	4	E3
Madeira [Portugal]	PT	8	E4
Malta	MT	C	E0
Moldova	MD	1	E4
Monaco	MC	8	E2
Morocco	MA	1	E2
Netherlands	NL	8	E3
Norway	NO	F	E2
Palestine	PS	8	E0
Poland	PL	3	E2
Portugal	PT	8	E4
Romania	RO	E	E1
Russian Federation	RU	7	E0
San Marino	SM	3	E1
Slovakia	SK	5	E2
Slovenia	SI	9	E4
Spain	ES	E	E2
Sweden	SE	E	E3
Switzerland	CH	4	E1
Syrian Arab Republic	SY	6	E2
Tunisia	TN	7	E2
Turkey	TR	3	E3
Ukraine	UA	6	E4
United Kingdom	GB	C	E1
Vatican City State	VA	4	E2
Yugoslavia	YU	D	E2

G.4.1.2 African Broadcasting Area

Table G.2 lists the PI and ECC symbols for African countries.

Table G.2

African Codes

Country/Area	ISO Code	Symbol for PI (Hex)	ECC (Hex)
Ascension Island	??	A	D1
Cabinda	??	4	D3
Angola	AO	6	D0
Algeria	DZ	2	E0
Burundi	BI	9	D1
Benin	BJ	E	D0
Burkina Faso	BF	B	D0
Botswana	BW	8	D1
Cameroon	CM	1	D0
Canary Islands [Spain]	ES	E	E0
Central African Republic	CF	2	D0
Chad	TD	9	D2
Congo	CG	C	D0
Comoros	KM	C	D1
Cape Verde	CV	6	D1
Cote d'Ivoire	CI	C	D2
Democratic Rep. of Congo	ZR	B	D2
Djibouti	DJ	3	D0
Egypt	EG	F	E0
Ethiopia	ET	E	D1
Gabon	GA	8	D0
Ghana	GH	3	D1
Gambia	GM	8	D1
Guinea-Bissau	GW	A	D2
Equatorial Guinea	GQ	7	D0
Republic of Guinea	GN	9	D0
Kenya	KE	6	D2
Liberia	LR	2	D1
Libya	LY	D	E1
Lesotho	LS	6	D3
Mauritius	MU	A	D3

Table G.2 (continued)

Country/Area	ISO Code	Symbol for PI (Hex)	ECC (Hex)
Madagascar	MG	4	D0
Mali	ML	5	D0
Mozambique	MZ	3	D2
Morocco	MA	1	E2
Mauritania	MR	4	D1
Malawi	MW	F	D0
Niger	NE	8	D2
Nigeria	NG	F	D1
Namibia	NA	1	D1
Rwanda	RW	5	D3
Sao Tome & Principe	ST	5	D1
Seychelles	SC	8	D3
Senegal	SN	7	D1
Sierra Leone	SL	1	D2
Somalia	SO	7	D2
South Africa	ZA	A	D0
Sudan	SD	C	D3
Swaziland	SZ	5	D2
Togo	TG	D	D0
Tunisia	TN	7	E2
Tanzania	TZ	D	D1
Uganda	UG	4	D2
Western Sahara	EH	3	D3
Zambia	ZM	E	D2
Zanzibar	??	D	D2
Zimbabwe	ZW	2	D2

Note: Countries or areas with no known ISO code are shown with a ?? code.

G.4.1.3 Former Soviet Union

Table G.3 lists the PI and ECC symbols for Soviet Union countries.

Table G.3
Soviet Union Codes

Country/Area	ISO Code	Symbol for PI (Hex)	ECC (Hex)
Armenia	AM	A	E4
Azerbaijan	AZ	B	E3
Belarus	BY	F	E3
Estonia	EE	2	E4
Georgia	GE	C	E4
Kazakhstan	KZ	D	E3
Kyrgyzstan	KG	3	E4
Latvia	LV	9	E3
Lithuania	LT	C	E2
Moldova	MD	1	E4
Russian Federation	RU	7	E0
Tajikistan	TJ	5	E3
Turkmenistan	TM	E	E4
Ukraine	UA	6	E4
Uzbekistan	UZ	B	E4

G.4.2 Allocations of Symbols for Countries in ITU Region 2

Table G.4 lists the PI and ECC symbols for countries in ITU Region 2.

Table G.4
ITU Region 2 Codes

Country/Area	ISO Code	Symbol for PI (Hex)	ECC (Hex)
Anguilla	AI	1	A2
Antigua and Barbuda	AG	2	A2
Argentina	AR	A	A2
Aruba	AW	3	A4
Bahamas	BS	F	A2

Table G.4 (continued)

Country/Area	ISO Code	Symbol for PI (Hex)	ECC (Hex)
Barbados	BB	5	A2
Belize	BZ	6	A2
Bermuda	BM	C	A2
Bolivia	BO	1	A3
Brazil	BR	8	A2
Canada	CA	B, C, D, E	A1
Cayman Islands	KY	7	A2
Chile	CL	C	A3
Colombia	CO	2	A3
Costa Rica	CR	8	A2
Cuba	CU	9	A2
Dominica	DM	A	A3
Dominican Republic	DO	B	A3
Ecuador	EC	3	A2
El Salvador	SV	C	A4
Falkland Islands	FK	4	A2
Greenland	GL	F	A1
Grenada	GD	D	A3
Guadeloupe	GP	E	A2
Guatemala	GT	1	A4
Guiana	GF	5	A3
Guyana	GY	F	A3
Haiti	HT	D	A4
Honduras	HN	2	A4
Jamaica	JM	3	A3
Martinique	MQ	4	A3
Mexico	MX	B, D, E, F	A5
Montserrat	MS	5	A4
Netherlands Antilles	AN	D	A2
Nicaragua	NI	7	A3
Panama	A	9	A3
Paraguay	PY	6	A3

Table G.4 (continued)

Country/Area	ISO Code	Symbol for PI (Hex)	ECC (Hex)
Peru	PE	7	A4
Puerto Rico	PR	1..9, A, B, D, E	A0
Saint Kitts	KN	A	A4
Saint Lucia	LC	B	A4
St Pierre and Miquelon	PM	F	A6
Saint Vincent	VC	C	A5
Suriname	SR	8	A4
Trinidad and Tobago	TT	6	A4
Turks and Caicos Islands	TC	E	A3
United States of America	US	1..9, A, B, D, E	A0
Uruguay	UY	9	A4
Venezuela	VE	E	A4
Virgin Islands [British]	VG	F	A5
Virgin Islands [USA]	VI	1..9, A, B, D, E	A0

G.4.3 Allocations of Symbols for Countries in ITU Region 3

Table G.5 lists the PI and ECC symbols for countries in ITU Region 3.

Table G.5
ITU Region 3 Codes

Country/Area	ISO Code	Symbol for PI (Hex)	ECC (Hex)
Afghanistan	AF	A	F0
Saudi Arabia	SA	9	F0
Australia	AU		
Australian Capital Territory		1	F0
New South Wales		2	F0
Victoria		3	F0
Queensland		4	F0
South Australia		5	F0

Table G.5 (continued)

Country/Area	ISO Code	Symbol for PI (Hex)	ECC (Hex)
Australia (continued)	AU		
Western Australia		6	F0
Tasmania		7	F0
Northern Territory		8	F0
Bangladesh	BD	3	F1
Bahrain	BH	E	F0
Myanmar [Burma]	MM	B	F0
Brunei Darussalam	BN	B	F1
Bhutan	BT	2	F1
Cambodia	KH	3	F2
China	CN	C	F0
Sri Lanka	LK	C	F1
Fiji	FJ	5	F1
Hong Kong	HK	F	F1
India	IN	5	F2
Indonesia	ID	C	F2
Iran	IR	8	F0
Iraq	IQ	B	E1
Japan	JP	9	F2
Kiribati	KI	1	F1
Korea [South]	KR	E	F1
Korea [North]	KP	D	F0
Kuwait	KW	1	F2
Laos	LA	1	F3
Macau	MO	6	F2
Malaysia	MY	F	F0
Maldives	MV	B	F2
Micronesia	FM	E	F3
Mongolia	MN	F	F3
Nepal	NP	E	F2
Nauru	NR	7	F1
New Zealand	NZ	9	F1

Table G.5 (continued)

Country/Area	ISO Code	Symbol for PI (Hex)	ECC (Hex)
Oman	OM	6	F1
Pakistan	PK	4	F1
Philippines	PH	8	F2
Papua New Guinea	PG	9	F3
Qatar	QA	2	F2
Solomon Islands	SB	A	F1
Western Samoa	WS	4	F2
Singapore	SG	A	F2
Taiwan	TW	D	F1
Thailand	TH	2	F3
Tonga	TO	3	F3
UAE	AE	D	F2
Vietnam	VN	7	F2
Vanuatu	VU	F	F2
Yemen	YE	B	F3

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] EIA/NAB, National Radio Systems Committee: United States RBDS Standard - Specification of the Radio Broadcast Data System (RBDS), Washington D.C., April 1998.

Appendix H

PTY Display Terms in Several Different Languages

H.1 Introduction

This Appendix gives details for the following languages: English, French, German, Spanish and Swedish.

Each of the following tables have a listing of the PTY codes from EN50067:1998 Annex F, showing the number, English language Programme TYpe and then a corresponding term (and not necessarily the literally translated one) of the other appropriate language, followed by their 8-character and 16-character display terms which may be used.

The listings in the different languages given here, were agreed upon within the RDS Forum. Corresponding terms for other languages can be found, when agreed, on the RDS Forum Web site, URL: www.rds.org.uk/.

It is very important to note, that "LARGE LETTERS" (upper case) and "small letters" (lower case) are used and that "spaces" are clearly shown using the " _ " notation. Not all receivers can display both "LARGE LETTERS" and "small letters," but they are specified, so that receivers which do display them can benefit from the enhanced readability of their use.

Table H.1

PTY Code Descriptions and Abbreviations in Multiple Languages: English

English	English	English
Number	Programme type	8-character display 16-character display
0	No programme type or undefined	None
1	News	News
2	Current Affairs	Affairs
3	Information	Info
4	Sport	Sport
5	Education	Educate
6	Drama	Drama
7	Culture	Culture
8	Science	Science
9	Varied	Varied
10	Pop Music	Pop _ M
11	Rock Music	Rock _ M
12	Easy Listening Music	Easy _ M
13	Light Classical Music	Light _ M
14	Serious Classical Music	Classics
15	Other Music	Other _ M
16	Weather	Weather
17	Finance	Finance
18	Children's Programmes	Children
19	Social Affairs	Social
20	Religion	Religion
21	Phone In	Phone _ In
22	Travel	Travel
23	Leisure	Leisure
24	Jazz Music	Jazz
25	Country Music	Country
26	National Music	Nation _ M
27	Oldies Music	Oldies
28	Folk Music	Folk _ M
29	Documentary	Document
30	Alarm Test	TEST
31	Alarm	Alarm !

Note: Large letters, small letters and the spaces are critical.

Table H.2

PTY Code Descriptions and Abbreviations in Multiple Languages: French

English	French	French	French
Num-ber	Programme type	Programme type	8-character display 16-character display
0	No programme type or undefined	Codification de programme non utilisée ou genre non défini	Aucun
1	News	Informations	Infos
2	Current Affairs	Magazine	Magazine
3	Information	Info-Service	Services
4	Sport	Sport	Sport
5	Education	Education	Educatif
6	Drama	Dramatique	Fiction
7	Culture	Culture	Culture
8	Science	Sciences	Sciences
9	Varied	Divertissement	Divers
10	Pop Music	Pop	M _ Pop
11	Rock Music	Rock	M _ Rock
12	Easy Listening Music	Chansons	Chansons
13	Light Classical Music	Classique Léger	M _ Cl _ Lég
14	Serious Classical Music	Musique Classique	Classiq
15	Other Music	Autre Musique	Autre _ M
16	Weather	Météo	Météo
17	Finance	Economie et Finances	Economie
18	Children's Programmes	Programmes pour enfants	Enfants
19	Social Affairs	Société	Société
20	Religion	Religion	Religion
21	Phone In	Ligne ouverte et interactivité	Forum
22	Travel	Voyages	Voyages
23	Leisure	Loisirs	Loisirs
24	Jazz Music	Musique de jazz	Jazz
25	Country Music	Musique de country	Country
26	National Music	Chansons du pays	Ch _ pays
27	Oldies Music	Musique rétro	Rétro
28	Folk Music	Musique folklorique	Folklore
29	Documentary	Documentaire	Document
30	Alarm Test	Test d'alarme	TEST
31	Alarm	Alerte	Alerte _ !

Note: Large letters, small letters and the spaces are critical.

Table H.3

PTY Code Descriptions and Abbreviations in Multiple Languages: German

English	German	German	German
Num- ber	Programme type	Programme type	8-character display 16-character display
0	No programme type or undefined	Keine Programmartkennung	Kein _ PTY Kein _ PTY
1	News	Nachrichtendienst	Nachrich Nachrichten
2	Current Affairs	Politik und Zeitgeschehen	Aktuell Aktuelle _ Info
3	Information	Service Programm	Service Service _ Programm
4	Sport	Sport	Sport Sport
5	Education	Lernen und Weiterbildung	Bildung Bildung
6	Drama	Hörspiel und Literatur	Hör+Lit Hörspiel _ + _ Lit
7	Culture	Kultur, Kirche und Gesellschaft	Kultur Kultur+Gesellsch
8	Science	Wissenschaft	Wissen Wissenschaft
9	Varied	Unterhaltendes Wort	Unterh Unterhaltung
10	Pop Music	Popmusik	Pop Pop _ Musik
11	Rock Music	Rockmusik	Rock Rock _ Musik
12	Easy Listening Music	Unterhaltungsmusik	U-Musik Unterhalt _ Musik
13	Light Classical Music	Leichte klassische Musik	L-Musik Leichte _ Klassik
14	Serious Classical Music	Ernste klassische Musik	E-Musik Ernste _ Klassik
15	Other Music	Spezielle Musikprogramme	--Musik Spezielle _ Musik
16	Weather	Wetter	Wetter Wetter
17	Finance	Wirtschaft	Wirtsch Wirtschaft
18	Children's Programmes	Kinderprogramm	Kinder Kinderprogramm
19	Social Affairs	Soziales	Soziales Soziales
20	Religion	Religion	Religion Religion
21	Phone In	Anrufsendung	Anruf Anrufsendung
22	Travel	Reiseinformation	Reise Reiseinformation
23	Leisure	Freizeit	Freizeit Freizeit
24	Jazz Music	Jazz	Jazz Jazz
25	Country Music	Countrymusik	Country Country _ Musik
26	National Music	Musik des Landes	Landes _ M Landesmusik
27	Oldies Music	Oldiemusik	Oldies Oldies _ Musik
28	Folk Music	Folklore	Folklore Folklore
29	Documentary	Feature	Feature Feature
30	Alarm Test	Alarmtest	Test Alarm _ Test
31	Alarm	Alarm	Alarm! Alarm! _ Alarm!

Note: Large letters, small letters and the spaces are critical.

Table H.4

PTY Code Descriptions and Abbreviations in Multiple Languages: Spanish

English	Spanish	Spanish	Spanish
Num- ber	Programme type	Programme type	8-character display 16-character display
0	No programme type or undefined	No se indica el tipo programa	Ninguno Ninguno
1	News	Noticias	Noticias Noticias
2	Current Affairs	Magazin	Magazine Magazine
3	Information	Información	Info Información
4	Sport	Deportes	Deportes Deportes
5	Education	Educación	Educa Educación
6	Drama	Drama	Drama Drama
7	Culture	Cultura	Cultura Cultura
8	Science	Ciencia	Ciencia Ciencia
9	Varied	Varios	Varios Varios
10	Pop Music	Música Pop	M _ Pop Música _ Pop
11	Rock Music	Música Rock	M _ Rock Música _ Rock
12	Easy Listening Music	Grand éxitos	G _ éxitos Grandes _ éxitos
13	Light Classical Music	Música Ligera	M _ Ligera Música _ Ligera
14	Serious Classical Music	Música Clásica	Clásica Música _ Clásica
15	Other Music	Otra Música	M _ Varia Música _ Varia
16	Weather	Información Meteorológica	Meteo Meteorología
17	Finance	Economía	Economía Economía
18	Children's Programmes	Infancia	Infancia Infancia
19	Social Affairs	Sociedad	Sociedad Sociedad
20	Religion	Religión	Religión Religión
21	Phone In	Opinión	Opinión Opinión-Oyentes
22	Travel	Viajes	Viajes Viajes
23	Leisure	Ocio	Ocio Ocio
24	Jazz Music	Música Jazz	M _ Jazz Música _ Jazz
25	Country Music	Música Country	Country Música _ Country
26	National Music	Música Nacional	Nacional Música _ Nacional
27	Oldies Music	Música de ayer	M _ Ayer Música _ de _ Ayer
28	Folk Music	Música Folk	M _ Folk Música _ Folk
29	Documentary	Documental	Docu Documental
30	Alarm Test	Test de Alarma	Prueba Prueba _ de _ Alarma
31	Alarm	Alarma	Alarma ¡ _ Alarma _ !

Note: Large letters, small letters and the spaces are critical.

Table H.5

PTY Code Descriptions and Abbreviations in Multiple Languages: Swedish*

English	Swedish	Swedish	Swedish
Num- ber	Programme type	Programme type	8-character display 16-character display
0	No programme type or undefined	Programtypen saknas eller är odefinierad	Pty _ sakn Pty _ saknas
1	News	Korta nyheter	Nyheter Nyheter
2	Current Affairs	Fördjupning av nyheter	Aktuellt Aktualiteter
3	Information	Allmän information	Info Information
4	Sport	Sport	Sport Sport
5	Education	Utbildningsprogram	Utbildn Utbildning
6	Drama	Teater och program om teater	Teater Teater
7	Culture	Kultur i bred mening	Kultur Kultur
8	Science	Vetenskapsprogram	Vetenskp Vetenskap
9	Varied	Underhållningsprogram	Underh Underhållning
10	Pop Music	Populärmusik	Pop Popmusik
11	Rock Music	Rockmusik	Rock Rockmusik
12	Easy Listening Music	Underhållningsmusik	Lättlyss Lättlyssnat
13	Light Classical Music	Lätt klassisk musik(ej kompletta verk)	L _ klass Lätt _ klassiskt
14	Serious Classical Music	Kompletta klassiska verk	Klassisk Klassisk _ musik
15	Other Music	Övrig Musik	Övrig _ m Övrig _ musik
16	Weather	Väderrapporter	Väder Väder
17	Finance	Ekonomiprogram	Ekonomi Ekonomi
18	Children's Programmes	Barnprogram	För _ barn För _ barn
19	Social Affairs	Program om sociala frågor	Socialt Sociala _ frågor
20	Religion	Andliga frågor	Andligt Andliga _ frågor
21	Phone In	Telefonväkteri	Telefon Telefonväkteri
22	Travel	Resor och semester	Resor Resor _ & _ semester
23	Leisure	Fritid och hobby	Fritid Fritid _ & _ hobby
24	Jazz Music	Jazzmusik	Jazz Jazzmusik
25	Country Music	Countrymusik	Country Countrymusik
26	National Music	Nationell musik	Nation _ m Nationell _ musik
27	Oldies Music	Klassisk pop	Oldies Gamla _ godingar
28	Folk Music	Folkmusik	Folkm Folkmusik
29	Documentary	Dokumentärer	Dokument Dokumentärer
30	Alarm Test	Provlarm	Prov Prov
31	Alarm	Larm	!!Larm!! !!Larm!!

Note: Large letters, small letters and the spaces are critical.

References

- [1] PTY display terms in several different languages, RDS Forum Document 98/009, Sept. 1998.

Appendix I

Character Sets for Alphanumeric Display

Three different alphanumeric character repertoires have been defined in Annex E of the RDS/RBDS standards; they are reproduced in Figures E.1 to E.3. Taken together, they permit the composition of texts indicating the name of the programme service and the constitution of radio data messages (e.g., RadioText) or alphanumeric paging calls. The three code tables were designed by the EBU. They contain almost all the characters in the international reference version of ISO Publication 646¹. The same codes have been given to each of these characters in all three tables. Care has been taken in the design of the coding tables to ensure that it will be possible to satisfy all the requirements within large geographical areas with each repertoire, and it is therefore likely that some receivers will be equipped to display only the characters included in one of the three repertoires. Up until 1997/98, RDS receivers have used only Figure I.1, or even only parts of it. Nonetheless, it is necessary to provide information identifying the repertoire in use in order to ensure that the display corresponds as closely as possible to the intentions of the broadcasting organisation when received on a receiver able to display characters from more than one

1. Including the figures 0 to 9 and punctuation; nonetheless, in certain cases, codes have been re-allocated to characters taken from the EBU repertoires, in accordance with the provision of ISO Publication 646.

repertoire. Since the default code table is Figure I.1, this indication is only required if one of the other two code tables is used or if one changes from one of them back to code table 1.

The repertoire tables were designed by the EBU with the view of covering the requirements satisfying the use of languages within the European broadcasting area. However, a compromise had to be made to keep these tables small in size. As a consequence of this, one or the other character from a particular language was left out, because it could be replaced by another. For example, in Greek, small theta, should be substituted by a capital theta.

In accordance with the practice in the videotext service, where more than one character repertoire is defined also, control codes have been allocated to distinguish between the basic (Figure I.1) and two auxiliary (see Annex E of the RDS/RBDS standards) code tables. The selection of the required code table is controlled by the transmission of the corresponding repertoire control characters—SI (0/15), SO (0/14), and LS2 (1/11 followed by 6/14)². In radio data, it is controlled by the transmission of one of the following pairs of repertoire control characters:

- 0/15, 0/15—code table of Figure I.1;
- 0/14, 0/14—code table of Figure E.2 in Annex E of the RDS/RBDS standards;
- 1/11, 6/14—code table of Figure E.3 in Annex E of the RDS/RBDS standards.

These characters do not occupy a space in the display, but 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 repertoire control character. In default of a repertoire control character, the display coding taking effect at address 0 should be assumed to be in accordance with the default code table given in Figure I.1. For example, the name "Radio 1" could be transmitted in type 0 groups as follows:

Characters:	Ra	di	oSP	1SP
Text segment address:	0	1	2	3

The text segment address: 0, 1, 2, 3 uses the character codes in pairs, respectively:

5/2,	6/1;
6/4,	6/9;
6/15,	2/0;
3/1,	2/0

to convey the name “Radio 1”.

Additional displayable characters for:																		
Displayable characters from the code table of ISO Norm 646								EBU common-core (7 languages)				Complete Latin-based repertoire (25 languages)						
				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			@	P		P	Š	š	Ž	ž	À	Á	Â	Ã
0	0	0	1	1	!	1	A	Q	a	q	ä	Ä	Å	Å	À	Á	Â	Ã
0	0	1	0	2	"	2	B	R	b	r	é	È	©	°	É	Ê	Ë	Æ
0	0	1	1	3	£	3	C	S	c	s	à	â	‰	’	È	Ê	Ë	œ
0	1	0	0	4	¤	4	D	T	d	t	í	ï	ñ	±	Í	Î	Ï	ü
0	1	0	1	5	%	5	E	U	e	u	í	ÿ	ö	÷	Î	Ï	Ï	ý
0	1	1	0	6	&	6	F	V	f	v	ó	ô	ñ	ñ	Ò	Ó	Ô	õ
0	1	1	1	7	¸	7	G	W	g	w	ð	ø	ø	ø	Ù	Ú	Û	ü
1	0	0	0	8	(	8	H	X	h	x	ú	û	π	μ	Û	Ü	Ý	Þ
1	0	0	1	9	)	9	I	Y	i	y	ù	ú	œ	¸	Ü	Û	Ÿ	Ž
1	0	1	0	10	*	:	J	Z	j	z	ñ	ñ	£	±	À	É	À	É
1	0	1	1	11	+	=	K	[⁽¹⁾	k	l	ç	ç	§	°	Ç	Ç	Ç	Ç
1	1	0	0	12	,	<	L	\	l	l	ç	ç	—	¼	Š	Š	Š	Š
1	1	0	1	13	-	=	M	] ⁽¹⁾	m	l	ß	ß	→	½	Ž	Ž	Ž	Ž
1	1	1	0	14	.	>	N	] ⁽¹⁾	n	l	ı	ı	↑	¾	Đ	Đ	Đ	Đ
1	1	1	1	15	/	?	O		o	u	ij	ı	ı	ı	ı	ı	ı	ı

Attention is drawn to the fact that low cost receivers may be able to display only the characters in Column 2 lines 0, 7, 12, 13, 14 and 15; Column 3 lines 0 to 9; Column 4 lines 1 to 15; Column 5 lines 0 to 10.

Figure I.1 Basic default code table for 218 displayable characters forming the complete EBU Latin-based repertoire. The characters shown in positions marked (1) in the table are those of the “international reference version” of ISO Publication 646 that do not appear in the complete Latin-based repertoire given in Appendix 2 of EBU document Tech. 3232 (2nd edition, 1982). (*Source:* EBU.)

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2. The notation A/B is used to designate the character appearing in column A on line B in the table.

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] EIA/NAB(1997) - National Radio Systems Committee: United States RBDS Standard Version 2.0, Specification of the Radio Broadcast Data System (RBDS).

Appendix J

Implemented RDS Features in Various Countries

J.1 Introduction

When broadcasters or transmission operators implement RDS, it is relatively easy to implement the static RDS features such as PI, PS, and AF, because a stand-alone RDS encoder at a transmitter site can be used. But programme-related RDS features require a data link from the studio to the RDS encoder, which may be inexpensive for just one single transmitter but quite expensive when the radio programme is going over a network of transmitters. An additional complexity exists when the network is split during certain hours of the day for regionalised programming. This is one of the main reasons why some major broadcast networks have not yet fully implemented the dynamic programme-related RDS features. Another reason is, of course, related to the fact that the production of radio programme-dependent RDS data requires additional human resources, and there is still some reluctance to invest in this activity given the fact that the number of receivers that support the dynamic RDS programme-related features (and specifically RadioText) is still relatively small in relation to the total number of receivers that are in use. This situation is, however, slowly changing because new RDS receivers tend to increasingly support dynamic programme-related RDS features.

The RDS Forum has for many years published a list of RDS features implemented in various countries. The following provides a summary that is derived from the data published in that list.

Almost all operators use a subcarrier injection level of ± 2 kHz. When this level is different, this fact is mentioned below.

Austria: ORF uses, in addition to the static RDS features, TP/TA and EON. RT is only tested, and not really implemented. CT is not used. PTY and traffic message channel TMC are being considered.

Belgium: VRT and RTBF use in addition to the static RDS features also TP/TA and EON. Only VRT uses PTY and RT. All these programmes use CT. TMC is being considered, and RTBF will start operation in late 1998.

Brazil: Interest is increasing and initial services are starting on several radio stations in Rio de Janeiro and São Paulo.

Croatia: Croatian radio uses in addition to the static RDS features also TP/TA and EON. CT is implemented and so is RP using an injection level of ± 4 kHz.

Denmark: DR uses, in addition to the static RDS features, TP/TA and EON. CT is implemented, but not PTY. RadioText is only tested, and not really implemented. TMC and DGPS will be implemented during 1998.

Finland: YLE uses almost all RDS features except MS. However PTY, PIN, and RT are only on two of their five networks. RP is used on two networks that use the higher injection level of ± 4 kHz.

France: Radio France uses, in addition to the static RDS features, TP/TA and EON. RT is used only in Paris on FIP. TMC is used in Paris and is planned for use by the motorway radio programme for 1998/99. RP is used on programmes of Radio France. The injection level in use is ± 4 kHz. Several commercial radio stations use TP, but they do not switch TA. CT is generally implemented on all stations. MS, PTY, and PIN are not yet used.

Germany: The public broadcasters use almost all RDS features, but many of them are only implemented partially. CT is sometimes not correctly implemented. PIN is not used. TMC was implemented in 1997 and for DGPS the RASANT system will be used nationwide. RP is partially used. Private broadcasters use (sometimes wrongly) dynamic PS. Several programmes use programme-related RadioText.

Greece: ERT uses CT and RT in addition to the static RDS features, but not EON. Private broadcasters often wrongly use dynamic PS.

Hong Kong: RTHK uses only the static RDS features and is testing TP, TA, PTY, and RT.

Hungary: Some programmes use the static RDS features, RT, and RP with an injection level of ± 4 kHz.

Ireland: RTE uses mainly static RDS features, but also PIN and EON. PTY and RT are planned. RP is used by RTE for its own staff, the injection level being ± 2.5 kHz. Their other networks use a deviation of ± 2.2 kHz.

Italy: RAI mainly uses the static RDS features and is testing the other ones. CT is not used. TMC is being tested in Northern Italy, starting from Bologna. Private radio stations use dynamic PS wrongly. Many of these use frequencies that are "offset" by 50 kHz.

Luxembourg: RTL uses mainly the static RDS features and CT. DGPS is being tested.

Netherlands: Radio programmes use the static RDS features and CT. RT is frequently implemented. Not used are PTY, PIN, and MS. RP and DGPS are partially used. A regular TMC service starts in the spring of 1998 on Radio 3. Some commercial radio stations wrongly use dynamic PS.

Norway: NRK programmes use the static RDS features, EON, CT, and RT. Local radios use also RT. The DGPS is being tested.

Portugal: Most radio stations use the static RDS features. RDP plans to start TMC in Lisbon in 1998.

Slovenia: Radio Slovenia uses, in addition to the static RDS features, TP/TA and EON. CT is implemented and so is RP, using an injection level of ± 4 kHz.

South Africa: SABC uses only the static RDS features and EON. RP is being tested.

Spain: RNE uses almost all RDS features. TMC will be implemented in Madrid and on the motorway to Barcelona and France. Private networks use mainly the static RDS features. PTY is used by some networks.

Sweden: SR has implemented all RDS features. Teracom operates DGPS and the Swedish Road Authority uses TMC nationwide. RP was in use for many years and has been closed down. Injection levels are either ± 2.5 or 3.0 kHz. Local radio stations use mainly the static RDS features and some test RT. Some private radio stations wrongly use dynamic PS.

Switzerland: SRG/SSR mostly use the static RDS features and EON. DGPS and TMC are planned. Some private stations wrongly use dynamic PS.

United Kingdom: BBC has implemented most RDS features except MS. Classic FM has implemented the static RDS features and RT. Furthermore, DGPS is implemented under the Additional Services Licence and on the same transmitters. TMC will be implemented in 1998. PTY and CT are also used on many independent radio stations.

United States: Radio stations are increasingly interested in using RDS, and in all metropolitan areas, several local radio stations now offer RDS, usually implemented with static features. There is much interest in programme-related features, with trials of RT and PTY in progress.

Appendix K

Web Site of the RDS Forum

The Web site of the RDS Forum provides many necessary references and up-to-date information for users of the RDS technology. It also offers the possibility to join the RDS Forum. The structure of the Web site is as outlined in Figure K.1.

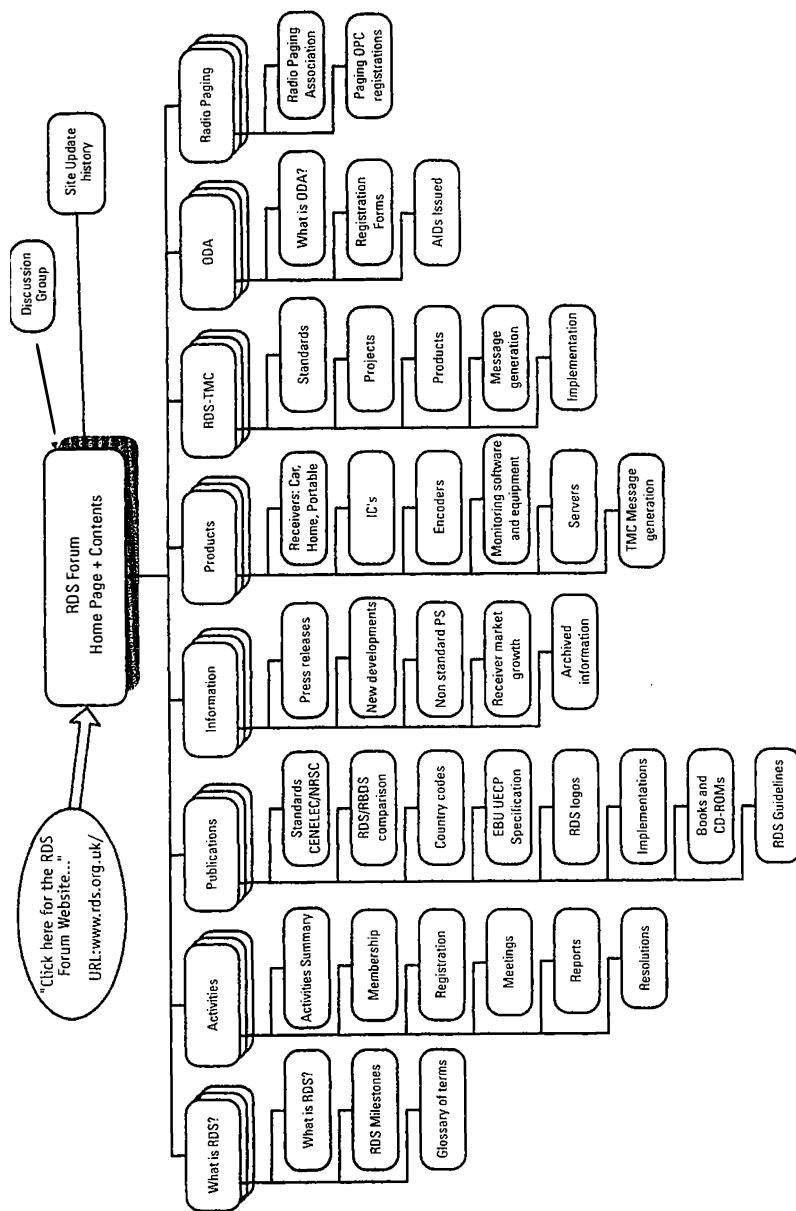


Figure K.1 The structure of the RDS Forum Web site. (Source: RDS Forum.)

Appendix L UECP Message Commands

L.1 Introduction

In Chapter 11, the Universal Encoder Communication Protocol (UECP) is described. This appendix gives more detail about the command format, shows how it is applied in two specific examples, and adds a list of all possible message commands to permit the reader to get an overview of the functionality that the UECP permits in data communications with RDS encoders.

L.2 Command Format

The message description is made as shown in Figure L.1. The first column indicates the descriptor of the message, which is detailed in the second column.

First column	Second column	Third column										
	<table><tr><th>MSB</th><th>LSB</th></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table>	MSB	LSB									
MSB	LSB											
MEC		Message element code										
DSN		Data set number										
PSN		Programme service number										
MED		Message element data										

Figure L.1 UECP message command format. (Source: EBU.)

Each element in Figure L.1 presents one byte where the bits are numbered from 7–0 (from left to right). For transmission of a respective message, each byte is represented by two hex symbols, of which the permitted range is indicated in the respective element. The message structure used is explained in Chapter 11, Figure 11.5.

The third column in Figure L.1 gives additional information for each row and describes the nature of the data that may be entered.

The coding of all RDS features is in the same format as used in the RDS/RBDS standards and if not, usually this is specifically mentioned in the particular command.

L.3 Examples of Specific Messages

L.3.1 Message to Set the PTY Code

The message element code is “07.” The function of this message command is to set the Programme TYpe information of the specified programme service on the specified data set(s). (See Figure L.2.)

Example

<07><00><05><08>

Set PTY to 8 in current data set, programme service 5.

L.3.2 Message to Set the PS Name

The message element code is “02.” The function of this message command is to set the PS name of the specified programme service(s) of the specified data set(s). (See Figure L.3.)

	MSB	LSB	
MEC	07		
DSN	00..FF		
PSN	00..FF		
MED	00..1F		PTY

Figure L.2 UECP message command to set the PTY code. (Source: EBU.)

	MSB	LSB	
MEC	02		
DSN	00..FF		
PSN	00..FF		
MED	20..FE		PS Character 1
MED	20..FE		PS Character 2
MED	20..FE		PS Character 3
MED	20..FE		PS Character 4
MED	20..FE		PS Character 5
MED	20..FE		PS Character 6
MED	20..FE		PS Character 7
MED	20..FE		PS Character 8

Figure L.3 UECP message command to set the PS name. (Source: EBU.)

The characters of the PS name are coded in conformity with the character sets described in Appendix I.

Example

<02><00><02><52><41><44><49><4F><20><31><20>

Set PS in current data set for programme service 2 to >RADIO_1_<

L.4 Listing of all Possible UECP Version 5.1 Message Commands

L.4.1 RDS Message Commands

1. PI;
2. PS;
3. PIN;
4. DI;
5. TA/TP;
6. MS;
7. PTY;
8. PTYN;

- 9. RT;
- 10. AF;
- 11. EON-AF;
- 12. Slow labelling codes;
- 13. Linkage information.

L.4.2 Open Data Application Commands

- 1. ODA configuration and short message command;
- 2. ODA identification group usage sequence;
- 3. ODA free-format group;
- 4. ODA relative priority group sequence;
- 5. ODA "burst mode" control;
- 6. ODA "spinning wheel" timing control.

L.4.3 Transparent Data Commands

- 1. TDC;
- 2. EWS;
- 3. IH;
- 4. TMC;
- 5. Free-format group.

L.4.4 Paging Commands

- 1. Paging call without message;
- 2. Paging call with numeric message (10 digits);
- 3. Paging call with numeric message (18 digits);
- 4. Paging call with alphanumeric message (80 characters);
- 5. International paging with numeric message (15 digits);
- 6. International paging with functions message;
- 7. Transmitter network group designation;
- 8. EPP transmitter information;
- 9. EPP call without additional message;

- 10. EPP national and international call with alphanumeric message;
- 11. EPP national and international call with variable-length numeric message;
- 12. EPP national and international call with variable-length functions message.

L.4.5 Clock Setting and Control

- 1. Real-time clock;
- 2. Real-time clock correction;
- 3. CT On/Off.

L.4.6 RDS Adjustment and Control

- 1. RDS On/Off;
- 2. RDS phase;
- 3. RDS level.

L.4.7 ARI Adjustment and Control

- 1. ARI On/Off;
- 2. ARI area;
- 3. ARI level.

L.4.8 Control and Setup Commands

- 1. Site address.
- 2. Encoder address;
- 3. Make PSN list;
- 4. PSN enable/disable;
- 5. Communication mode;
- 6. TA control;
- 7. EON-TA control;
- 8. Reference input select;
- 9. Data set select;

10. Group sequence;
11. Group variant code sequence;
12. Extended group sequence;
13. PS character code table selection;
14. Encoder access right;
15. Communications port mode configuration;
16. Communications port speed configuration;
17. Communications port timeout configuration.

L4.9 Bidirectional Commands (Remote and Configuration Commands)

1. Message acknowledgement;
2. Request message.

L4.10 Specific Message Commands

1. Manufacturer's specific command.

References

- [1] EBU, Universal Encoder Communications Protocol UECP-version 5.1, European Broadcasting Union, 17A, Ancienne Route, CH-1218 Geneva, Switzerland Aug. 1997.

Appendix M Glossary and Abbreviations

M.1 Glossary

This glossary provides brief descriptions of the RDS features and some other definitions that are useful in the overall context of broadcasting. The RDS features follow, in alphabetical order.

M.1.1 Alternative Frequencies (AF) List

The AF feature is intended to give information on the frequency of the various transmitters broadcasting the *same* programme in the same or adjacent reception areas, to enable receivers equipped with a memory to store the list(s), and to reduce the time for switching to another transmitter. This facility is particularly useful for mobile car and portable receivers (see Chapter 3).

M.1.2 Clock Time (CT) and Date

The CT feature is intended to update/synchronise a free-running clock in an RDS receiver. In conformity with ITU-R Recommendations, broadcast time and date codes use coordinated universal time (UTC) and modified Julian date (MJD). However the listener/user will not use this information directly and the conversion to local time and date will be made in the receiver's circuitry. CT is

used as a time stamp by various RDS applications and thus it *must* be transmitted accurately set (see Chapter 5).

M.1.3 Decoder Identification (DI) and Dynamic PTY Indicator (PTYI)

The DI and dynamic PTYI features are indicators that use designated bits to indicate which of several possible operating modes are in use with the broadcast audio, to allow a decoder to be set in a receiver to the correct mode, and to indicate if PTY codes in the transmission are dynamically switched (see Chapter 4).

M.1.4 Extended Country Code (ECC)

The ECC feature is intended to supplement information supplied by the PI that together provide a unique country code identification. The PI code only permits the definition of 15 different country codes, which are shared, so they do not permit the unique identification of the country of broadcasting origin (not necessarily of transmission). The ECC feature (using eight bits) together with the country identification in the PI code, describe a unique combination (see Chapter 3).

M.1.5 Enhanced Other Networks (EON) Information

The EON feature can be used to update information stored in a receiver about programme services *other than* the one being received. AFs, the PS name, the TP and TA flags, as well as PTY and PIN information can all be transmitted for each other service in a two minute period (see Chapter 5).

M.1.6 Emergency Warning System (EWS)

The EWS feature is intended to provide for the coding of confidential warning messages. These messages will be broadcast only in case of systems testing and actual emergency, and will only be evaluated by special receivers (see Chapter 5).

M.1.7 In-House Applications (IH)

The IH feature allows broadcasters or transmission operators to use a small amount of the RDS data capacity for their own purposes, such as monitoring equipment, systems status, and remote switching. The applications of this

data may be decided by each operator and will only be evaluated by special receivers.

M.1.8 Music Speech Switch (MS)

The MS indicator feature provides a two-state flag signal to inform a receiver that either music or speech is being broadcast at that time. This signalling may permit a receiver equipped with two separate volume controls (one for music and one for speech) to be automatically selected for these two conditions so that the listener could preadjust the balance to suit individual listening requirements.

M.1.9 Open Data Applications (ODA)

The ODA feature is designed to allow data applications not previously specified in EN 50067:1998 [1] to be conveyed in a number of allocated groups in an RDS transmission. The groups allocated are indicated by the use of type 3A groups, which are used to identify to a receiver the particular data application in use in accordance with the registration details in the EBU/RDS Forum Open Data Applications Directory (see Chapter 9).

M.1.10 Programme Identification (PI)

The PI feature is a code intended to help a receiver manage received data and particularly to discern the specific programme, associated data, and area/country of the broadcast. The code is not intended for direct display and is assigned to individual radio programme services to enable it to be distinguished from all other programme services. One important application of this code is to enable a receiver to search automatically for an alternative frequency in the case of bad reception of the programme to which the receiver is tuned. The criteria for changeover to a new frequency is the presence of a better signal having the *same* PI code (see Chapter 3).

M.1.11 Programme Item Number (PIN)

The PIN feature comprises a simple code to enable receivers and recorders designed to make use of this feature to respond to a particular programme item(s) that a user has preselected. Use is made of the scheduled programme time, to which the day of the month is added in order to avoid ambiguity (see Chapter 4).

M.1.12 Programme Service (PS) Name

The PS name feature is designed to provide information for an RDS receiver to display the name of the radio programme service instead of, for example, the tuned frequency being displayed. The PS is formatted for eight character displays using either LARGE or small characters—for example, >Classic_<. The PS name is intended to inform the listener what programme service is being broadcast. The programme service name is not intended to be used for automatic search tuning and must *not* be used for giving sequential information (see Chapter 4).

M.1.13 Programme Type (PTY)

The PTY feature uses an identification code, transmitted with each programme item, which is intended to specify the current Programme Type from 29 possibilities. This code may be used for various tuning modes and can assist a suitable receiver and/or recorder to be preset to respond only to programme items of the desired type. The PTY feature also carries an alarm functionality (and testing) to switch on the audio when a receiver is operated in a waiting/muted reception mode (see Chapter 4).

M.1.14 Programme Type Name (PTYN)

The PTYN feature is used to further describe the current PTY. PTYN permits the display of a more specific PTY description that the broadcaster can freely decide (e.g., PTY = 4: Sport and PTYN: Football). The PTYN is not intended to change the default characters used to display the PTY whose code is used during search or wait modes, but only to show in detail the Programme Type once tuned to a programme. If the broadcaster is satisfied with a default PTY name, it is not necessary to use additional data capacity for PTYN. PTYN is not intended to be used for automatic PTY selection and must not be used for giving sequential information (see Chapter 4).

M.1.15 Radio Paging (RP)

The RP feature of RDS is intended to provide Radio Paging using existing VHF/FM broadcasts as a delivery mechanism, thereby avoiding the need for a dedicated network of transmitters. Subscribers to a paging service require a special paging receiver in which the subscriber address code is stored (see Chapter 8).

M.1.16 RadioText (RT)

The RT feature allows the transmission of text messages up to 64 characters in length to be conveyed primarily to consumer home receivers. Shorter messages are also possible, and they may be frequently altered at a reasonable rate to allow, for example, programme-related information such as music title, conductor, orchestra, and CD reference number in order to decide on the CD to be purchased (see Chapter 4).

M.1.17 Traffic Announcement (TA) Flag

The TA indicator feature is a two-state flag signal to inform a receiver whether there is a traffic announcement on-air or not. This signalling may permit a receiver to switch automatically from any audio mode to the traffic announcement, switch on the traffic announcement automatically when the receiver is in a waiting reception mode and the audio signal is muted, or switch from a programme to another one carrying a traffic announcement (see Chapter 6).

M.1.18 Transparent Data Channels (TDC)

The TDC feature is designed to allow the transmission of free-format nonprogramme-related data in one of 32 channels. TDC was developed for closed user group applications (and is not available in consumer receivers), and special receivers would be required to respond to such data. Now that ODA has been specified, it is not expected to be used for all new applications (see Chapter 5).

M.1.19 Traffic Message Channel (TMC)

The TMC feature was developed to permit coded traffic and travel information to be conveyed to specialised consumer receivers and navigation systems, to give language-*independent* responses/displays when travelling across countries in close proximity to one another. The TMC feature is a special case of an ODA using a predefined group type (8A) and type 3A groups. The TMC system is fully defined in a family of CEN standards in the number sequence: ENV 12313 (see Chapter 7).

M.1.20 Traffic Programme (TP) Flag

The TP indicator feature is a two-state flag signal to inform a receiver whether the transmission being received carries traffic announcements or not. The TP

flag must only be set on transmissions that dynamically switch on the TA indicator flag *during* traffic announcements. The signal may be used during automatic search tuning (see Chapter 3 and 6).

M.2 Additional Definitions

In all areas of broadcasting, new technologies are being introduced. Furthermore, deregulation of broadcasting is leading to new relationships among those involved with broadcast services.

This has led to many new functional responsibilities, and the former (limited) definition of the word *broadcaster* needs to be redefined. This word has now acquired colloquially different, assumed meanings according to the state of development in any particular area/country. The key to explaining the functional responsibilities of a broadcaster and associated functions is to select good descriptive word(s) or phrases and define the elements and functions of that word.

The set of words and definitions that follow was originally developed for the RDS situation and has since been considered in the DAB context. Thus, appropriate combinations can be used for any situation, including where RDS and DAB carry the same service. These definitions were adopted by CEN TC 278 SWG 4.1 for use in standards developed therein and have been used in the CEN standard ENV 12313-1.

M.2.1 Broadcaster

A *broadcaster* is a traditionally incorporated organisation responsible for a continuous strand of programmes, their quality, and programme-associated data, as well as being responsible for the overall coordination of “broadcast transmissions” (often, a broadcaster is the licensee of a national regulator). A broadcaster is normally a *programme service provider* (of radio and/or television programmes) and may sometimes obtain programmes from another programme service provider. A broadcaster may also be a data service provider (e.g., RDS-TMC in Germany).

M.2.2 Programme Service Provider

A *programme service provider* is an organisation that manages and originates programmes (radio and/or television programmes) and associated data for broadcast. This will often be carried out by a broadcaster, but allows for the subtle distinction where a separate company is commissioned to produce a

programme, together with associated data (e.g., text of teacher notes for an educational series).

M.2.3 Data Service Provider

A *data service provider* is an organisation that manages any data service by gathering data, processing that data, and marketing and providing the data service. A data service provider then negotiates for the use of the necessary data bandwidth with a broadcaster and/or transmission operator. A data service provider is responsible for the “quality” of data to his or her customers and must provide suitable customer support. Editorial control over the data may be part of a service agreement between data service provider and broadcaster. (For example, a TMC service may require the broadcaster to apply some editorial control so that both TMC messages and other broadcast services such as spoken or teletext traffic and travel information—possibly derived from more than one source—are not contradictory.) It is recognised that when talking about a particular service, the word *data* is often dropped; however, this could lead to confusion with a programme service provider, so care should be exercised to ensure the context is well understood.

M.2.4 Transmission Operator

A *transmission operator* is an organisation responsible for the *actual* transmission of the full broadcast signal, including the audio programme, programme-associated data, and data services. Normally, a transmission operator is contracted by a broadcaster to perform the transmission task.

M.2.5 Network Operator

A *network operator* is an organisation contracted to supply both programme and data circuits interconnecting data service provider, programme service provider, broadcaster, and transmission operator. According to the connections, various protocols may be used (e.g., EBU UECF, Eureka 147 ETI and STI, and TPEG).

M.3 Abbreviations

Many abbreviations are commonly used in the context of RDS, and these are listed in Table M.1 in alphabetical order. This includes RDS features and

associated components (e.g., specialised items such as the Linkage Set Number). Most of these abbreviations are explained in Section M.1.

Table M.1
RDS Features and Associated Abbreviations

AID	Application Identification (for ODA)
AF	Alternative Frequencies list
CI	Country Identifier/country code
CT	Clock Time (and date)
DI	Decoder Identification
ECC	Extended Country Code
EG	Extended Generic indicator
EON	Enhanced Other Networks information
EWS	Emergency Warning System
IH	In-House applications
ILS	International Linkage Set indicator
LA	Linkage Actuator
LI	Linkage Identifier
LSN	Linkage Set Number
MS	Music Speech identifier
ODA	Open Data Applications
PI	Programme Identification
PIN	Programme Item Number
PS	Programme Service name
PTY	Programme TYpe
PTYI	Dynamic Programme TYpe Indicator
PTYN	Programme TYpe Name
RBDS	Radio Broadcast Data System
RDS	Radio Data System
RP	Radio Paging
RT	RadioText
TA	Traffic Announcement flag
TDC	Transparent Data Channels
TMC	Traffic Message Channel
TP	Traffic Programme flag

The RDS capability to convey Radio Paging has introduced a number of specialised abbreviations used in connection with the basic paging (BP) and extended paging protocols (EPP), and these are listed in Table M.2. Operation of a Radio Paging service also requires certain other RDS features to be implemented (e.g., CT) and their abbreviations are listed in Table M.1.

The RDS-TMC specification ENV 12313-1 introduces further concepts that are specific to RDS-TMC and their abbreviations are listed in Table M.3.

M.4 Acronyms

In the field of new radio data transmission technologies, and particularly of RDS-TMC, many acronyms have been used to describe functionality,

Table M.2
Radio Paging Abbreviations

BPP	Basic paging protocol
CCF	Current carrier frequency
CS	Cycle selection
EPP	Extended paging protocol
IT	Interval numbering
NI	National international id
OPC	Operator code
PAC	Paging area code
RP	Radio Paging
SI	System information
STY	Subtype group

Table M.3
TMC Abbreviations

AFI	Alternative frequency indicator
LTN	Location table number
MGS	Message geographical scope
SID	Service identifier
TMC	Traffic Message Channel

development projects, and specifications. A selection of those most commonly encountered is shown in Table M.4.

Table M.4
Acronyms Commonly Encountered

Acronym	Description
AA	Automobile Association (U.K.)
ADAC	Allgemeiner Deutscher Automobil Club (German automobile users' association)
ADR	ASTRA Digital Radio
AHS	Automated Highway Systems
ALERT	Advice and Problem Location for European Road Transport (pre 1997 meaning)
ALERT	Agreed layer for European RDS-TMC (introduced July 1997 for EC service MoU)
ALERT-C	Advice and Problem Location for European Road Transport, version C.
ALERT-Plus	Advice and Problem Location for European Road Transport, version Plus
AM	Amplitude modulation
AMDS	AM Data System (a baseband coding specification from the EBU for data broadcasting on LF, MF, and HF)
ARI	Autofahrer Rundfunk Information (drivers radio information, used in Austria, Germany, Luxemburg, and Switzerland)
ARD	Arbeitsgemeinschaft der öffentlich rechtlichen Rundfunkanstalten der Bundesrepublik Deutschland (the German public broadcasters' association)
ARTS	Advanced Road Transportation Systems (Japan) A European regional project (EC/DG VII)
ATT	Advanced transport telematics (EC)
ATT-ALERT	Advanced Transport Telematics-Advice and Problem Location for European Road Traffic ATT(DRIVE) Project V2028
AVICS	Advanced Vehicle Control & Infrastructure Systems
BBC	British Broadcasting Corporation (the U.K. public broadcaster)
BEVEI	BEssere Verkehrrs Information (Better Traffic Information—an ARD (WDR and SWF) and partners RDS-TMC pilot)
BR	Bayerischer Rundfunk (German public radio broadcaster)
CARMINAT	French consortium originally established as a Eureka research project
CEM	Consumer electronics manufacturer
CEMA	Consumer Electronics Manufacturers Association (a branch of EIA in the United States)
CEMT	Conférence Européene des Ministres des Transports (see also ECMT)

Table M.4 (continued)

Acronym	Description
CEN	Comité Européen de Normalisation (responsible for RDS-TMC standards)
CENELEC	Comité Européen de Normalisation Electrotechnique (responsible for the RDS standard)
CENTRICO	A European regional project (EC/DG VII)
CES	Consumers Electronics Show (United States)
CORD	CORD is a strategic assessment of ATT implementation through ATT(DRIVE) Project V2056
CORVETTE	A European regional project (EC/DG VII)
CRC	Cyclic redundancy check
DAB	Digital audio broadcasting, also called digital radio
DARC	Data radio channel (a system for high-speed data broadcasting in FM radio)
DATEX	An initiative to coordinate data protocols used between TICs (subject of EC Service MoU)
DEFI	Definition of first phase implementation (Pan-European RDS-TMC road information service)
DG VII	Directorate General VII of the European Commission (concerned with transport)
DG XIII	Directorate General XIII of the European Commission (concerned with Telematics)
DGPS	Differential Global Positioning Satellite/System (see also GPS)
DRIVE	Dedicated Road Infrastructure for Vehicle safety in Europe
DSP	Data service provider
DVB	Digital video broadcasting
EACEM	European Association of Consumer Electronics Manufacturers
EBU	European Broadcasting Union (see also UER)
EC	European Commission
ECMT	European Conference of Ministers of Transport (see also CEMT)
ECORTIS	A joint project with FORCE to develop final solutions for RDS-TMC implementations
ECU	European currency unit (see also MECU)
EDIFACT	Electronic Data Interchange For Administration, Commerce, and Trade
EDRM	European digital road map
EIA	Electronics Industry Association (United States)
EN	European standard (see prEN)
ENV	European prestandard (see prENV)

Table M.4 (continued)

Acronym	Description
EPISODE	European Preoperational Implementation Survey On further Development and Evaluation of RDS-TMC (broadcast sector)
ERTICO	European Road Transport Telematics Implementation Coordination Organisation
ETS	European telecommunications standard from ETSI
ETSI	European Telecommunications Standards Institute
EU	European Union
EUREKA	European Research Coordination Agency
EUROAD	Location coding concept in RDS-TMC for the provision of transborder event messages
FM	Frequency modulation
FORCE	A joint project with ECORTIS to develop final technology and solutions for RDS-TMC implementations
GDF	Geographical data file
GEMINI	Generation of Event Messages in the New Integrated Road Transport Environment through the ATT(DRIVE) Project V2038
GIS	Geo-information systems
GPS	Global Positioning Satellite/System (see also DGPS)
GSM	Groupe Systeme Mobile (standard for worldwide digital cell phone technology)
HMI	Human/machine interface (see also MMI)
HSDS	High-speed data system (FM broadcasting)
IEC	International Electrotechnical Committee
IFA	Internationale Funkausstellung (International fair of audiovisual consumer products)
IRT	Institut für Rundfunktechnik (German public broadcasters' technology research centre)
IRTE	Integrated road transport environment
ISO	International Standards Organisation
ITS	Intelligent transport systems (EC)
ITT	Intelligent transport telematics (EC)
ITU	International Telecommunication Union
IVHS	Intelligent Vehicle Highway System (United States)
LMSK	Level controlled modulation shift keying
MECU	Million European currency units (see also ECU)
MMI	Man machine interface (see also HMI)

Table M.4 (continued)

Acronym	Description
MoU	Memorandum of Understanding (see also ALERT and DATEX)
MS	Member states (of European union)
NAB	National Association of Broadcasters (United States)
NDR	Norddeutscher Rundfunk (German public radio broadcaster)
NOB	Nederlands Omroepproductie Bedrijf nv (Netherlands public broadcast production company)
NOS	Nederlandse Omroep Stichting (Netherlands public radio broadcaster)
NRSC	National Radio Systems Committee of NAB/EIA (United States)
OSI	Open systems interconnection
ORF	Österreichischer Rundfunk – Austrian public radio broadcaster)
PES	Pan-European service
PLEIADES	Paris London Corridor Evaluation of Integrated ATT and DRIVE Experimental Systems through a ATT(DRIVE) Project V2047
prEN	Draft European standard (see also EN)
prENV	Draft European prestandard (see also ENV)
PSP	Programme service provider
RAI	Radiotelevisione Italiana (Italian public radio broadcaster)
RASANT	Radio Aided Satellite Navigation Technique (a German DGPS system for FM radio)
RF	Radio France (French public radio broadcaster)
RPA	Radio Paging Association (operated within the RDS Forum)
RTCC	Regional Traffic Control Centre
RTCM	Radio Technical Commission for Maritime Services
RTD	Research and technology demonstration
RTI	Road traffic informatics
RTT	Road transport telematics
RVC	Road vehicle communications (an ECMT subgroup)
SDR	Süddeutscher Rundfunk (German public radio broadcaster)
SERTI	A European regional project (EC/DG VII)
SME	Small- and medium-sized enterprise
SR	Sveriges Radio (the Swedish public radio broadcaster)
SWF	Südwestfunk (German public broadcaster)
SWG	Sub-working group (refer to CEN or CENELEC)
TAP	Telematics applications programme

Table M.4 (continued)

Acronym	Description
TC	Technical committee (réfer to CEN or CENELEC)
TCC	Traffic Control Centre
TDF	Télédiffusion de France (a transmission operator that is part of France Telecom group)
TELTEN	TELematic implementation on the Trans European Road Network (DG VII project)
TEN	Trans-European network
TPEG	Transport programme experts group specification developed by the EBU
TERN	Trans-European Road Network
TIC	Traffic Information Centre (in some countries this only covers road information)
TICS	Traffic Information Centre Systems (refer to CEN TC204)
TTI	Traffic and travel information
TTIC	Traffic and Travel Information Centre
UECP	Universal Encoder Communication Protocol (specification from the EBU)
UER	Union Européenne de Radio-Télévision (see also EBU)
VDA	Verband Deutscher Automobilhersteller (German automobile industry association)
VHF/FM	Very high frequency/frequency modulation (used in Band II, 87.5-108 MHz)
VBI	Vertical blanking interval (in analogue television that makes it possible to accommodate data)
VICS	Vehicle Information & Communication System
VIKING	A European regional project (EC/DG VII)
VMS	Variable message signs
WAP	Wireless application protocol
WDR	Westdeutscher Rundfunk (German public broadcaster)
WG	Working group (refer to CEN and CENELEC)

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About the Authors

Dietmar Kopitz has coordinated all RDS development work within the European Broadcasting Union since the 1970s, participating in specification writing, elaboration of the implementation guidelines, and the European and U.S. standardisation processes. He is a founder and co-chairman of the RDS Forum. In the field of RDS-TMC, he led the European Commission funded EPISODE project.

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