Information on Radio Data System (RDS)

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Background

Radio Data System (RDS) is a standard way of transmitting digital information over an FM analog audio broadcast channel. In the USA a slightly different standard called Radio Broadcast Data System (RBDS) is used. In this document any reference to RDS also applies to RBDS unless otherwise stated. See the Wikipedia page for RDS `http://wikipedia.org/wiki/Radio_Data_System` for additional information and very useful external links.

The RDS standard is given by IEC-62106:2009. The official version of this document may be purchased from IEC (International Electrotechnical Commission), however, an unofficial draft version is available for free from the RDS forum's web site. With a little searching, you can also find the older 1999 official version for free on the internet.

RBDS is a combination of IEC-62106 and another document from the National Radio Systems Committee (NRSC) called NRSC-4-B, available for free from `http://www.nrscstandards.org`. The main differences between RBDS and RDS are different rules for PI and PTY codes.

A good book on RDS was published in 1999: "RDS: The Radio Data System" by Dietmar Kopitz and Bev Marks, ISBN 0-89006-744-9.

It is now common for traffic information to be sent over RDS using Group 8A, Traffic Message Channel (TMC) packets. TMC is described in ISO standard 14819 "Traffic and Traveler Information (TTI) — TTI messages via traffic message coding," with 4 parts:

ISO 14819-1:2003 Coding protocol for Radio Data System — Traffic Message Channel (RDS-TMC) using ALERT-C

ISO 14819-2:2003 Event and information codes for Radio Data System — Traffic Message Channel (RDS-TMC)

ISO 14819-3:2004 Location referencing for ALERT-C

ISO 14819-6:2006 Encryption and conditional access for the Radio Data System — Traffic Message Channel ALERT C coding

Before the ISO version was released, earlier versions of TMC were given by CEN standard ENV 12313.

See `http://wikipedia.org/wiki/Traffic_message_channel` for more information on TMC.

Data format

This document describes the data format once the signal has been decoded and error correcting codes have been applied. The data consists of a series of "packets" that RDS calls Groups. Each Group contains four Blocks named A through D. Each block contains 16 bits of data. All Groups have the following bit layout:

- Block A

  16 PI (Program Identification) code that identifies the programming broadcast by the station.

- Block B

  4 Group Type code.

  1 Version code:
  0 = A
  1 = B

  1 Traffic Program code:
  0 = No Traffic Alerts
  1 = Station gives Traffic Alerts

  5 PTY (Program Type) code

  5 Depends on Group Type and Version codes.

- Block C

  16 Depends on Group Type and Version codes. Version A has data, version B usually has a duplicate PI also found in Block A.

- Block D

  16 Depends on Group Type and Version codes.

The Group Type and Version codes indicate the format of Blocks C and D and the 5 low bits of Block B. In this document and the official documents, the Group Type code and Version code are combined. (Example: 4A.)

Block A always has the Program Identification (PI) code that uniquely identifies the programming broadcast by the station. Typically, a network of stations will share a PI code. This permits the radio to stay tuned to a network, instead of a station. Whenever a station becomes weak, the radio will automatically search for another stronger station with the same PI code. Some stations may switch between network and local programming. In this case, the station may switch to a different PI code while broadcasting local programming. This is usually done by changing the coverage area code inside the PI code.

In RDS, the PI code has the following bit layout:

4 Country code. Cannot be 0.

4 Coverage area code.

8 Assigned ID code. Cannot be 0.

While radio networks may still exist in Europe, Canada, and other areas, they no longer exist in the USA. (They were destroyed by competition from TV.) For many decades, each station has had a unique program format. There are nationally syndicated programs, but each program makes a separate broadcast deal with a station in each market. (In some cases, this can be over 600 stations.) Even when a company owns multiple stations across the country, they always have unique programming on each station.

Because there are no networks in the USA and there are many thousands of stations, the European PI codes found in RDS are inadequate to meet the needs of the USA. This caused the creation of the RBDS standard.

In RBDS, a formula is used to encode the station's call sign into a PI code. (See the RBDS document for how this is done.) The encoding scheme used was designed to maintain compatibility with RDS, except that RBDS does not normally use coverage area codes.

Note: Occasionally, two USA local stations will broadcast identical programming. (This is called simulcasting.) This is done to increase the coverage area in rural areas. In this case, both stations become a mini network and should share the same PI code. The PI code used is based on the call sign of one of the stations.

The PI code was originally designed to meet the needs of Europe. Later, when RDS was spread to the rest of the world, the country code had to be expanded. Group Type 1A packets contain an 8 bit Extended Country Code (ECC). This permits having unique ID codes across the world. The European broadcasting area uses ECC E0 to E4.

According to RDS (IEC-62106:1999, which is out of date but freely available on the Internet), the USA uses ECC A0 with country codes 1-9, A, B, D, E. (Country codes C and F are unassigned for ECC A0.) Canada is assigned ECC A1 and country codes B, C, D, E. Mexico is assigned ECC A5 and country codes B, D, E, F. However, RBDS (NRSC-4-B:2011) says country code C is used by Canada and F by Mexico, but does not indicate what ECC is then used. RBDS also says country codes B, D, E are reserved for networks with coverage area codes and that they are coordinated with Canada and Mexico. When these country codes are used, the PI codes they form behave exactly as PI codes in RDS. The following table gives the allocation of country codes for RBDS:

Country code	**Coverage area code**	**Usage**
1-A	No	Call sign encoded PI (USA only)
B, D, E	Yes	NPR (USA) and CBC (Canada) networks
C	Yes	Canada
F	Yes	Mexico

Although RBDS reserves a few PI codes for the National Public Radio (NPR) network, it does not appear that these stations use their network PI codes because most (if not all) NPR stations have unique programming for each station.

It appears to this author, that RBDS ignores the ECC and has "reserved" country codes B-F for Canada and Mexico. This permits North American stations and receivers to ignore ECCs and to assume that country codes 1-A are RBDS and B-F are RDS.

There is one exception to the above rules permitted by RBDS. If a station is broadcasting Traffic Message Channel (TMC) groups (packets), it may set the high nibble to 0x1, regardless of the PI code it should normally use. Apparently, this tells TMC receivers that the station is located in North America.

The original intent of the PI code is to have a unique ID for each programming format to be used internally by the receiver. The user would never see this code. (Although some receivers now show it as a hexadecimal number.) However, because US codes are based on the station's call sign, it is common for US receivers to display the station's call sign, derived from the PI code.

The Program Type (PTY) code gives the type of programming found on the station. This code can change throughout the day if the Dynamic PTY flag is set (see below.) The codes chosen for RDS are fine for Europe but have limited value in the USA. For example, I doubt there is any station in the USA that would use the categories "Cultures," "Science," or "Documentary."

RBDS changes most PTY codes to values more useful for the USA. Examples include "Top 40," "Foreign Language," "Religious Music," "Religious Talk," "Spanish Music," "Spanish Talk," and "Hip Hop." It is unlikely that any of these would be used in Europe.

RDS text characters use custom character sets. However, the lower half of each set is basically ASCII. (See official documents for details.) Whenever a text character is received that the receiver does not understand, it should replace it with a space.

The following table gives the Group Types we will discuss in this document. Most other Group Types are for custom use or are reserved. (See official documents for info on the other Group Types.)

Type	Contents
0A/B	Basic information
1A	Additional information
2A/B	Radio Text
3A	Setup open data application
4A	Date and time
10A	Program Type Name
15B	Basic information

Group 0A/B — Basic tuning and switching information

- Block B (low 5 bits)

  1 TA (Traffic announcement):
  0 = No traffic announcements at this moment. Normal programming on audio channel.
  1 = Traffic announcement currently being broadcast on audio channel.

  1 MS (Music/Speech):
  0 = Speech
  1 = Music

  1 Decoder-Identification control code. Contains a 1 bit segment of a four bit code.

  2 Segment number for Program Service name and Decoder-Identification control code.

- Block C

  16 Two alternate frequencies (version A) or duplicate PI (version B.) Some stations are part of a network of stations with common programming. This field gives the frequency of the neighboring stations in the network. See official documents for more info.

- Block D

  8 Program Service name, first character in segment.

  8 Program Service name, second character in segment.

The Program Service name is 8 characters that identifies the station with a name or slogan. However, most stations now use it to print a scrolling message that should be sent as a Radio Text message, despite the fact that this is prohibited by RDS. (Stations do this because most car radios do not display Radio Text messages.)

The Program Service name is broadcast in segments with each Group (packet) containing one segment. Each segment contains two characters. Therefore, the full name requires four segments.

The Decoder-Identification control code is a four bit code that provides miscellaneous info. Just as the Program Service name is divided into segments, so is the Decoder-Identification control code. Each group contains a 1 bit segment so four segments are required. The first segment (0) contains the most significant bit, the last segment (3) contains the least significant bit.

The following table shows the relationship between segment numbers and the Program Service name and Decoder-Identification control code:

Segment	PS characters	DI bit
0	1, 2	3 MSB
1	3, 4	2
2	5, 6	1
3	7, 8	0 LSB

The following table gives the meaning for each bit in the Decoder-Identification control code:

Segment	DI bit	Value and meaning
0	3	0 = Static PTY code
		1 = Dynamic PTY code
1	2	0 = Not compressed audio
		1 = Compressed audio
2	1	0 = Not artificial head
		1 = Artificial head (Binaural audio)
3	0	0 = Monophonic audio
		1 = Stereophonic audio

Group 1A — Program Item Number and slow labeling codes

- Block B (low 5 bits)

  5 Radio Paging codes. See official documents.

- Block C

  1 Link Actuator. See official documents.

  3 Variant code. See below.

  12 Data. See below.

- Block D

  16 Program Item Number. See official documents.

The Variant code gives the data format for the 12 bit Data field. The following table gives the bit layouts for the Data field for the two most interesting Variants. (See official documents for other Variant codes.)

- Variant = 0

  4 Paging. See official documents.

  8 Extended Country Code (ECC). See description of PI codes above.

- Variant = 3

  4 Reserved.

  8 Language code. (Annex J says Language code is 8 bits.)

The most interesting Language codes are: (See IEC-62106 Annex J for other codes.)

Language code	Meaning
0x00	Unknown or not applicable
0x09	English

Group 2A/B — Radio Text

- Block B (low 5 bits)

  1 A/B flag. Toggles whenever a new message is started.

  4 Segment number for Radio Text.

Version 2A:

- Block C

  8 Radio Text, first character in segment.

  8 Radio Text, second character in segment.

- Block D

  8 Radio Text, third character in segment.

  8 Radio Text, fourth character in segment.

Version 2B:

- Block C

  16 Duplicate PI

- Block D

  8 Radio Text, first character in segment.

  8 Radio Text, second character in segment.

The Radio Text (RT) message is either 64 (Group 2A) or 32 (Group 2B) characters. It describes the current program being broadcast or provides other useful information like traffic reports. Radio Text is broadcast in segments with each Group (packet) containing one segment. There are 16 segments. Group 2A has four characters per segment. Group 2B has two characters per segment.

The following table shows the relationship between segment numbers and Radio Text:

Segment	Group 2A RT characters	Group 2B RT characters
0	1, 2, 3, 4	1, 2
1	5, 6, 7, 8	3, 4
...		
15	61, 62, 63, 64	31, 32

Radio Text supports the following control characters:

Char	Name	Usage
0x0D	CR	Marks end of message
0x0A	LF	Optional line break
0x0B		End of headline
0x1F		Soft hyphen

The end of headline character may be placed anywhere within the first 32 character positions and indicates that the text up to that point is considered by the broadcaster to be the "headline" portion of the message. It is inserted by the broadcaster on the assumption that a 2 line by 16 character format has been adopted on the receiver. It may stand in place of a space character in the message.

The soft hyphen indicates the position(s) in long words where the author of the text would prefer a receiver to break a word between display lines if there is a need to do so. It has application only for multi-line non-scrolling displays.

The A/B flag is toggled whenever a new message is started. At this point the receiver should reset the Radio Text receive buffer. The A/B flag will maintain its current state while segments for the current message are broadcast repeatedly. Note that RDS permits stations to shorten the message by skipping segments at the end.

Group 3A — Application identification for open data

- Block B

  4 Group Type code for ODA packet.

  1 Version code for ODA packet:
  0 = A
  1 = B

- Block C

  16 Message.

- Block D

  16 Application Identification (AID)

RDS supports broadcasting custom protocols using undefined Groups Types (packets.) These packets are called Open Data Application (ODA) packets. To use an ODA packet, you must identify the custom protocol you are using and what Group Type and Version the protocol will be using. This is done by sending a Group 3A packet.

The Application Identification (AID) uniquely identifies which protocol is being used. Its value is assigned by the maintainers of the RDS and RBDS standards.

Some packet types can either be used for ODA or for a purpose defined by the RDS standard. For example, Groups 5A/B can be used for ODA or for Transparent Data Channels (TDC). If a broadcaster wants to use a packet for its default purpose, it sends a Group 3A packet with an AID of 0.

There is a 16 bit Message in Group 3A packets for custom information for each protocol.

Group 4A — Clock-time and date

- Block B (low 5 bits)

  3 Unused.

  2 Modified Julian Date (MJD) high bits.

- Block C

  15 Modified Julian Date (MJD) low bits.

  1 Hour high bit.

- Block D

  4 Hour low bits.

  6 Minute

  1 Sign of Offset:
  0 = Positive - Add offset to date/time.
  1 = Negative - Subtract offset from date/time.

  5 Offset to convert UTC to local time. Units in half hours.

If all date and time fields are set to zero then the packet is meaningless and should be ignored.

The date and time given are in UTC. The offset can be used to convert UTC to local date and time.

The date is given in Modified Julian Date (MJD) form. It represents the number of days since November 17, 1858. Officially, the date is supposed to be restricted to values up to 99999. However, the binary field can contain values up to 131071. I assume the official range will be increased once the current date reaches the current limit. I also suspect that most equipment already support dates up to 131071.

Hour is from 0 to 23. Minute is from 0 to 59.

The offset is an unsigned number. The sign flag indicates if the offset should be added to or subtracted from the date and time. The offset is given in half hour increments.

The following code fragment can be used to convert to local time:

```
unsigned long date_time; // combines date and time in units of minutes
unsigned long MJD; // days since November 17, 1858
unsigned short hour, minute;
short offset;
bool sign;

// initialize MJD, hour, minute, offset, and sign with received RDS data
...
// combine date and time
date_time = MJD*24*60 + hour*60 + minute;
// adjust offset from units of half hours to minutes
offset *= 30;
// determine sign of offset
if(sign) offset = -offset; // make negative
// compute local date/time
date_time += offset;
// break down date and time
minute = date_time%60;
date_time /= 60;
hour = date_time%24;
date_time /= 24;
MJD = date_time;
```

Group 10A — Program Type Name

- Block B (low 5 bits)

  1 A/B flag. Toggles whenever a new message is started.

  3 Unused.

  1 Segment number for Program Type Name.

- Block C

  8 Program Type Name, first character in segment.

  8 Program Type Name, second character in segment.

- Block D

  8 Program Type Name, third character in segment.

  8 Program Type Name, fourth character in segment.

The Program Type Name (PTYN) is 8 characters that identifies the type of programming broadcast by the station. This is intended to supplement the Program Type (PTY) code which has only 32 possible values.

The Program Type Name is broadcast in segments with each Group (packet) containing one segment. Each segment contains four characters. Therefore, the full name requires two segments.

The following table shows the relationship between segment numbers and the Program Type Name:

Segment	PTYN characters
0	1, 2, 3, 4
1	5, 6, 7, 8

The A/B flag is toggled whenever a new name is started. At this point the receiver should reset the Program Type Name receive buffer. The A/B flag will maintain its current state while segments for the current name are broadcast repeatedly. Note that RDS permits stations to shorten the name by skipping the second segment.

Group 15B — Fast basic tuning and switching information

Blocks A and B have the same format as Group Type 0A/B. Block C is a duplicate of block A. Block D is a duplicate of block B.

This Group (packet) probably exists to improve the odds of receiving this basic information on a station with poor reception.