

A silent revolution -

RDS for FM radio

RDS Forum authors team

A silent revolution - RDS for FM radio

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An RDS Forum Publication

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This book is dedicated to all colleagues within the EBU and the RDS Forum, who helped to make this RDS success story happen. Thanks for the many opportunities we had to work together.

Dietmar Kopitz

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RDS on the basic subcarrier - What is it all about ? by Dietmar Kopitz



This Chapter gives a detailed overview about RDS and RBDS. It provides much of the necessary background that will help to better understand the details given in later chapters about RDS and RDS2 and their implementation options.



RadioText Plus is used in more recent car receivers that display for RTmusic items the title and the artist's name. BMW has such a product.

OBJECTIVES TO BE ACHIEVED WITH RDS

The Radio Data System, RDS, offers broadcasters a flexible data-transmission channel accompanying VHF/FM sound broadcasts. Additionally, RDS offers the possibility for data service providers to introduce new data services. Thus, RDS can accommodate a wide range of possible implementation options. Optional RDS2 with the three additional subcarriers extends these possibilities.

Following a long period of system development in the 1970s and early 1980s, and field trials in several European countries, RDS is now implemented in over 50 countries worldwide, in Europe, in some Asia Pacific region countries, South Africa, Latin America and in North America (USA, Canada and Mexico, using RBDS).

SYSTEM CHARACTERISTICS

RDS development had started with a number of functional requirements to be fulfilled. These were:

- The radio data signals must be compatible; they must not cause interference to the reception of sound programme signals on existing receivers.

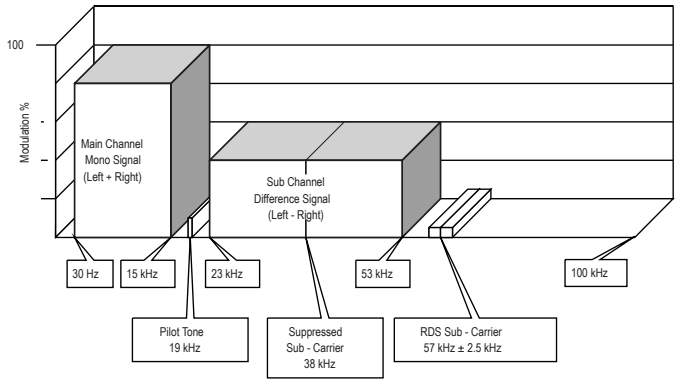
- The data signals must be capable of being reliably received within a coverage area as great as that of the monophonic main programme signal.

- The usable data rate provided by the basic 57 kHz data channel should support the requirements of station and programme identification and provide scope for future developments.

- The message format should be flexible to allow the message content to be tailored to meet the needs of individual broadcasters at any given time.

- The system should be capable of being reliably received on low-cost receivers.

These requirements have significantly influenced the choice of the modulation parameters and the baseband coding characteristics.



Spectrum of a pilot-tone stereo multiplex with the basic RDS data stream using the 57 kHz subcarrier.

The multiplex spectrum of a stereophonic FM broadcast signal comprises the small signal level RDS signal, centred around the 57 kHz subcarrier which is the third harmonic of the 19 kHz pilot-tone of the stereophonic modulation system. This choice of the subcarrier was critical for meeting the requirement to minimize data signal interference to the audio channels for existing receivers. The other parameter that is critical to achieve the same goal is the injection level of the data. The higher it is, the more rugged is the data service but under multipath conditions the interference to the audio channels will also increase. It was found in field trials that a minimum was ±1 kHz and a reasonable operational choice was ±2 kHz. At these levels there is usually virtually no interference from the data channel detectable during radio listening.

The use of the biphase coded data signal also helps compatibility with the audio programme signal because coherent components at around 57 kHz were found to introduce data-modulated crosstalk in receivers that used a phase-locked loop (PLL) stereo decoder.

The bit rate of the basic RDS 57 kHz subcarrier data stream is 1187.5 bits/s (1187.5 = 57'000 / 48) which, with biphase coding and the specified 100 % cosine roll-off filtering, gives an overall bandwidth for the data signal of approximately 5 kHz, centred on 57 kHz.

Choice of baseband coding

Multipath, in an FM system, produces distortion of the demodulated signal. The distortion components resulting from the relatively large amplitude sound programme signal components can easily swamp the data signal. When a vehicle moves along a road characterized by multipath interference, the quality of the received FM signal varies rapidly. At some moments, the demodulated audio programme is distorted; at others, it is completely broken up. The very important lesson learned from the 1980 and 1982 field trials in the Bern/Interlaken area was that reliable mobile reception is only possible when the radio data message stream is broken up into small independent entities (the RDS groups of 104 bits), each of which can be received, decoded and applied independently of other parts of the data stream. This factor was crucial to the basic design of the RDS system and must be clearly understood for the design of new applications within RDS, such as those that can be carried within the ODA feature.

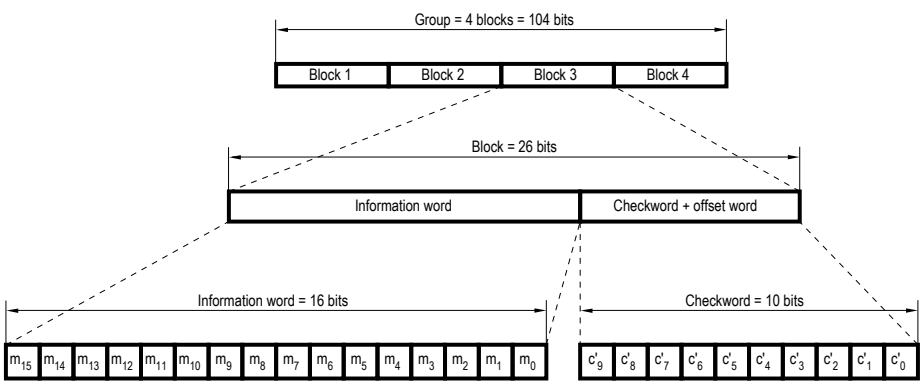
As with many other serial data transmission systems designed for mobile communications, the data stream in RDS had to be partitioned into data groups and blocks. The groups consist of four blocks, each being 26 bits long. The group thus consists of 104 bits. One block consists of a 16 bit/2 byte long information word and a 10 bit CRC checkword to which is added an offset word that creates the flywheel synchronisation mechanism that makes RDS so rugged under severe multipath receiving conditions.

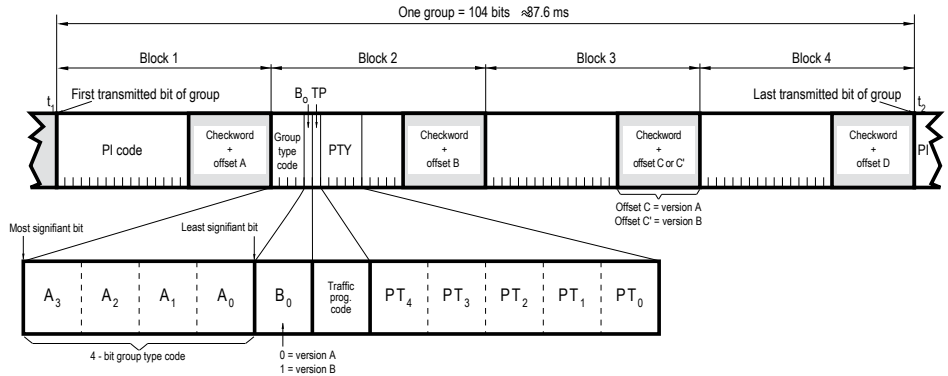
Message format and addressing

The RDS coding is structured so that the messages to be repeated most frequently and which need a short acquisition time, normally occupy the same fixed positions within a group. This allows decoding without reference to any block outside that containing the information. The first block of each group always contains a Programme Identification (PI) code; the Programme Type (PTY) code and the Traffic Programme (TP) flag occupying fixed positions in bock 2 of every group.

The group type code is specified by a 4-bit code which defines the group type (from 0 to 15). This code is sent in the first four bits of the second block of every group. In addition, the fifth bit of this block defines the “version” (A or B) of the group type. In version A groups the PI code is inserted in block 1 only. In version B, the PI code is inserted in block 1 and 3.

Groups are, in general, reserved for a particular application or message type, e.g. RadioText, Clock Time and Date, Long PS, etc.





The above two figures explain the coding of the message format and the group addressing on the basic subcarrier 0.

APPLICATIONS OF RDS

The Radio Data System permits some 20 functions to be implemented. The eight most important ones (also called the basic RDS features) are implemented everywhere and are intended primarily to be used in the mobile reception mode with car radios having automated tuning functions:

- Programme Identification (PI) - a 16-bit code containing a country symbol, a regional code, and a number permitting the identification of the broadcaster and the particular programmed.

- Programme Service name (PS) - comprising eight alphanumeric characters from an uppercase and lower-case basic character set, and serving to give the listener information about the name of the programme, e.g. “Radio 1”.

- RadioText (RT and RT+) - 64 characters of text for display by receivers.

The new RDS standard edition IEC 62106:2018/2023 includes the following significant technical changes with respect to the previous version IEC 62106:2015:

- The standard has been totally re-structured:

  Part 1: RDS system overview: Modulation characteristics and baseband coding
  Part 2: RDS message format: Coding and definition of RDS features
  Part 3: Coding of Open Data Applications
  Part 4: Registered code tables
  Part 5: Marking of RDS1 and RDS2 devices
  Part 6: Compilation of technical specifications for Open Data Applications in the public domain
  Part 9: RBDS
  Part 10: Universal Encoder Communication Protocol - UECP (with support for RDS2)
- Provision has been made to carry RDS on optional multiple data-streams (RDS2).
- Data in the additional data-streams is using a newly defined group type C data structure.
- AF coding below 87.6 MHz (down to 64.1 MHz) can use ODA-AID 0x6365 (see IEC 62106-6).
- Long PS (UTF-8) support has been added using group type 15A (see IEC 62106-2).
- Coding for EWS, TDC, IH and RP is no longer detailed in the RDS standard as these can use in future the ODA concept.
- Translated PTY terms for 20 languages were added (see IEC 62106-4).
- New are receiver profiles, conformity requirements, certification and compliance test (see IEC 62106-5).
- Obsolete and no longer part of the RDS standard are: MS (Group 0A, 0B and 15B) certain DI codes (mono/stereo, artificial head, compression), Language code, and PIN (Group 1A).
- In 2021 Part 2 was issued as Edition 2: It contains a specification RFT for RDS2 file transfer.
- In 2023 IEC 62106-6 ED.2 for RDS2 the ODAs for Station logo, Slideshow and Internet connection were added.

Summary of all eight Parts of the RDS standard IEC 62106

Part 1 (2018) : This document defines the RF modulation characteristics of the RDS system with legacy RDS using only the 57 kHz subcarrier and the optional three upper subcarriers for RDS2, all intended for application to VHF/FM sound broadcasts in the range 64.0 MHz to 108.0 MHz, which can carry either stereophonic (pilot-tone system) or monophonic programmes in full conformity with ITU-R Recommendations BS.450 and BS.643.
Part 2 (2021) : This document specifies the coding of the three data group types used in RDS, group type A and B for legacy RDS, using only the 57 kHz subcarrier, and group type C used for RDS2 on the optional three upper subcarriers. All RDS features and functions including the Open Data feature ODA are described. New is the RDS2 File Transfer protocol RFT. For RDS, the CRC-16 is also specified.
Part 3 (2018) : This document specifies the process to be used to create ODAs. These are new RDS applications that can be added to RDS/RDS2 by fully maintaining the compatibility with receivers designed without any knowledge about them. These applications are identified by a unique code that has to be registered. The procedure to be used is detailed here.
Part 4 (2018) : This part provides a number of tables for use in the implementation of the RDS system such as the RDS specific character set, country codes and extended country codes and the PTY tables for RDS (not for RBDS) with translations into a number of languages . This document specifies also the procedure to be used for registering a new value in an existing table or the registration of a new table.
Part 5 (2018) : This part defines receiver profiles and criteria that can be used for marking RDS receiver devices.
Part 6 (2023) : This part contains the technical specifications for Open Data Applications in the public domain. These include RadioText Plus, enhanced Radiotext using UTF-8 character coding and AF lists when frequencies below 87.5 MHz need to be used. These are all legacy RDS ODAs. The public RDS2 ODAs for Station logo, Slideshow with optional images and text and Linking the receiver to IP service options are added as from 2023.
Part 9 (2021) : This is the RBDS specification for North America. RBDS uses RDS as specified in all other Parts. However, with respect to Part 2, a few important differences apply. They are all listed here. The content of this document is taken over from a national US standard, of which the reference is NRSC- 4-B. The US NRSC retired this document now as Part 9 has become its replacement.
Part 10 (2021) : This is the specification of the Universal Encoder Communication Protocol – UECP. The UECP satisfies the need for harmonized RDS encoder communication protocols and facilitates the interworking of various RDS system components, such as RDS servers, data bridges and encoders, regardless of the supplier. The UECP supports all current RDS features and the optional RDS2 implementations. All new developments using the ODA protocol with legacy RDS only using the 57 kHz subcarrier and/or RDS2 with up to three additional subcarriers are supported. The UECP is backwards compatible with all previous versions published by the EBU and the RDS Forum since 1994. Some RDS features initially specified by the EBU and no longer used were however deleted, as laid out in Part 2.

NOTE: All previous versions of the RDS specifications published by the EBU, US NRSC, Cenelec and the IEC (before 2018) have been cancelled and do no longer apply. Backwards compatibility has been maintained, however. Anything unclear in the above specifications shall be communicated back to the RDS Forum.

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The RDS Encoder Communication Protocol UECP by Dietmar Kopitz



This Chapter explains the need for a communication protocol to be used between broadcaster's RDS data server (studio) or data service provider (e.g. for TMC) and RDS encoders at the FM transmitter sites. The EBU had developed a specification, first published in 1994, for this protocol which is commonly called the UECP (Universal Encoder Communication Protocol). It was continuously updated by the RDS Forum and it became in 2021 Part 10 of the RDS standard. This new Part 10 the UECP has also been adapted to support RDS2. It is recommended to use the UECP, especially when RDS is implemented within a network of several transmitters. If not, alternative modes of communication are possible where the disadvantage is that they will be encoder manufacturer specific.

WHY THE EBU DEVELOPED, WITH ENCODER MANUFACTURERS, THE UECP?

In the early nineties, when the EBU decided to support the requirement that the various existing and implemented RDS encoder communication protocols should be harmonized, such harmonization would, when achieved, 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 above all 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 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 impossible.

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 very widely accepted, was based on harmonized environmental and encoder models.

The UECP is a layered communication protocol which is in line with the OSI reference model (ISO Recommendation 7498). The UECP in its current version (IEC 62106-10) has been updated by the RDS Forum since 1993.

The UECP model and protocol provides 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 RDS functionality required.

Organizations and manufacturers that have contributed within the EBU and later within the RDS Forum to the elaboration of the UECP specification included: Aztec, Auditem/WorldCast Systems, BBC, Deutsche Telekom, Ericsson (formerly Teli), IRT, Qbit, RE Technology, Rohde & Schwarz, TDF, Telefunken Sendertechnik and Teleray.

RDS signal monitoring, analysing and testing by Dietmar Kopitz



This chapter gives some practical advice about how to use a product to look into the details of the RDS signal performance of any new or existing RDS receiver and analyses the content of the FM/RDS signals found on air.



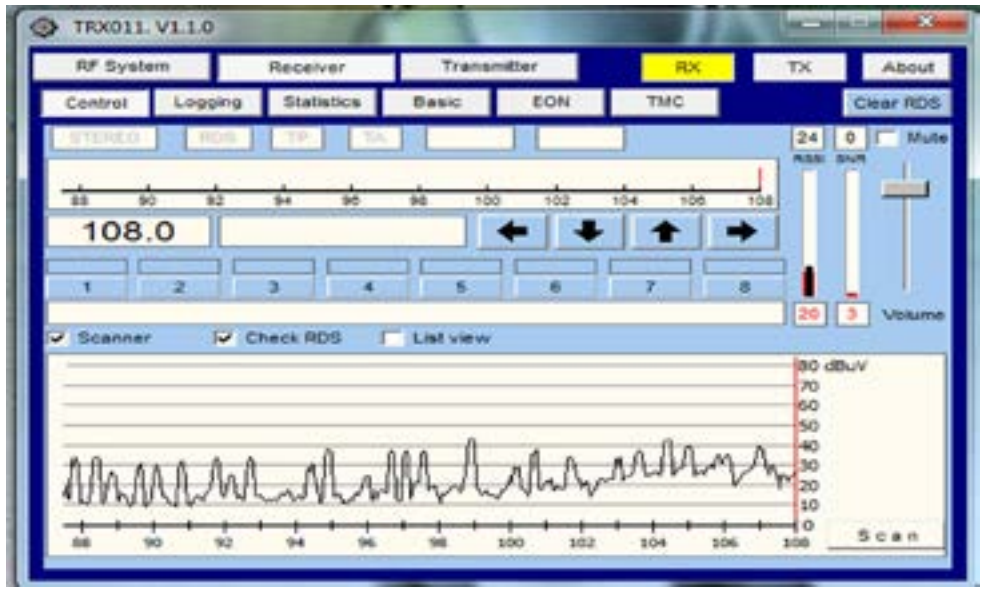
On screen we can see the band scan result. It only took a minute to get the complete picture about RDS on air. The TRX011 box with its rod antenna is visible on the left.

Note that the product described below is no longer available in 2025, because its designer, RDS Forum member Joop Beunders passed away in December 2023. A replacement product is already under development.

I think, everyone interested in RDS would like to know what RDS signals are really on air. Here was the solution. In June 2012 RDS Forum Member MacBe (in the Netherlands) presented a new product, the TRX011 that I immediately perceived as a "wonder box". The new product was relatively inexpensive and had the size of about a cigarette box. It was designed to be used with a Windows PC and it had to be connected to the PC via USB and no separate power supply for the box was needed.

The software for analysing and setting the transmitted RDS data was part of the package and regular updates from MacBe were included. Note specifically that you can transmit with this wonder box your own RDS data. It has implemented all RDS features including those that use the ODA, such as RDS-TMC and RT+. As eRT is an ODA, you can test it as well,with a string of UTF-8 coded bytes with characters of any language.

The wonder box designed by Joop Beunders, who was one of those RDS design engineers that had the longest professional experience with RDS. Joop started his RDS development work in the late seventies with Philips in Eindhoven (Netherlands) building hardware for the Dutch RDS candidate system SPI. To enable his TRX011 product to receive and transmit RDS data, he was using an integrated circuit designed some years ago by another RDS Forum Member, Silicon Labs in Texas, now Skyworks. They brought this chip, Si 4721, to the market to permit small add-on products to be made for the many iPod and MP3 players available then. This was to permit these music players to transmit within a short range of a few meters distance the music and data (mainly titles and artist names) via FM/RDS to supply them to a free FM channel to which the car radio could then be tuned (examples of such device suppliers were Belkin, Gear and many more). The IC can transmit any of the RDS data features so that, if the add-on device is well designed, such a short-range transmitter could signal via AFs an alternative free FM channel when the car is driven over a long distance. The information where such a free channel will be available would be obtained from a band-scan performed during the journey, carried out at frequent intervals by the receiver part of this IC.



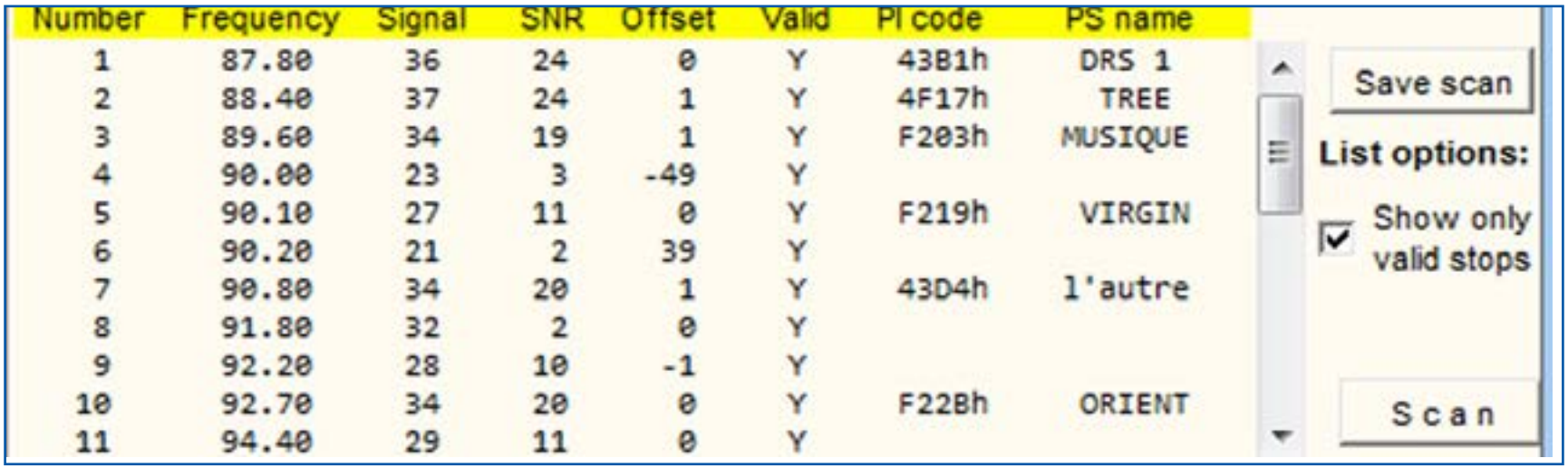
The band scan result can also be displayed as a list showing the PI code and the PS name.

The first thing one wants to know is how many FM stations can be received in the location where one is. More cecently, if you use the DS016 docking station with the RX014 (two later products from MacBe), you can even remotely monitor RDS and RDS2 at any location using the Internet for the RDS data transfer to your own location.

We start to make a band-scan and my particular monitoring result is that in Geneva (in my office) we can receive about 30 FM stations; some of them transmit the same programme on different FM channels. In terms of radio programmes available, the scan result tells us that there are over 20. The complete band scan took only one minute.

We want of course to know whether these stations all use

RDS. To find that out we just have to look up the scan list report provided by the TRX011 box. We found that all the FM transmitters receivable in the Geneva region use RDS.



Here we see the scan result as list giving for RDS the PI code and the PS name.

Now we would like to investigate a special problem related to the static PS name feature. We put the emphasis here on "static" as the PS name has in the RDS data stream the function to serve as an identifier to the listener of the name to the tuned programme (or any other alternative radio programme on air). The PS name is composed of eight alphanumeric characters and some examples are

BBC R1, RADIO 21, MUSIQUE, BR INFO.

Here in the Geneva region, where we can receive Swiss and French radio programmes, we have noticed that the majority of FM stations use dynamic text instead of the static PS name identifier required by the RDS standard. Why? The reason is that in RDS for any text transmission one should use the RadioText (RT) feature. However, in the early years of RDS, most car radios did not implement RT for a number of reasons, one being not to distract the driver (responding to a traffic safety statement for moving vehicles, issued by the European Commission – which is the Recommendation 2007/78/EC) and also to save on the need to use a larger display to better present the text information. The latter condition has changed a bit now due to the fact that a large display is needed anyway for a number of other reasons and thus it could also be used for RT, and therefore most newer car radios have implemented the RT feature, but by default and for the above mentioned safety reasons it may be disabled.

Here, in Fig. 9 - 2 one can see an example of a screenshot display from a relatively recent car radio. This speaks for itself. Do you realise now the possibilities that RDS can now offer since the new RDS standard version has been published in 2018? These will for sure enlarge the market for RDS enabled FM receivers and software that will help to supply the corresponding information in the broadcast studio environment.



Figure 9 - 2 – Display screenshot of eRT coded in Urdu and Hindi using UTF-8 character decoding

Figures 9-3 and 9-4 on the next pages, show more examples with enhanced RadioText eRT and eRTplus coded with UTF-8.

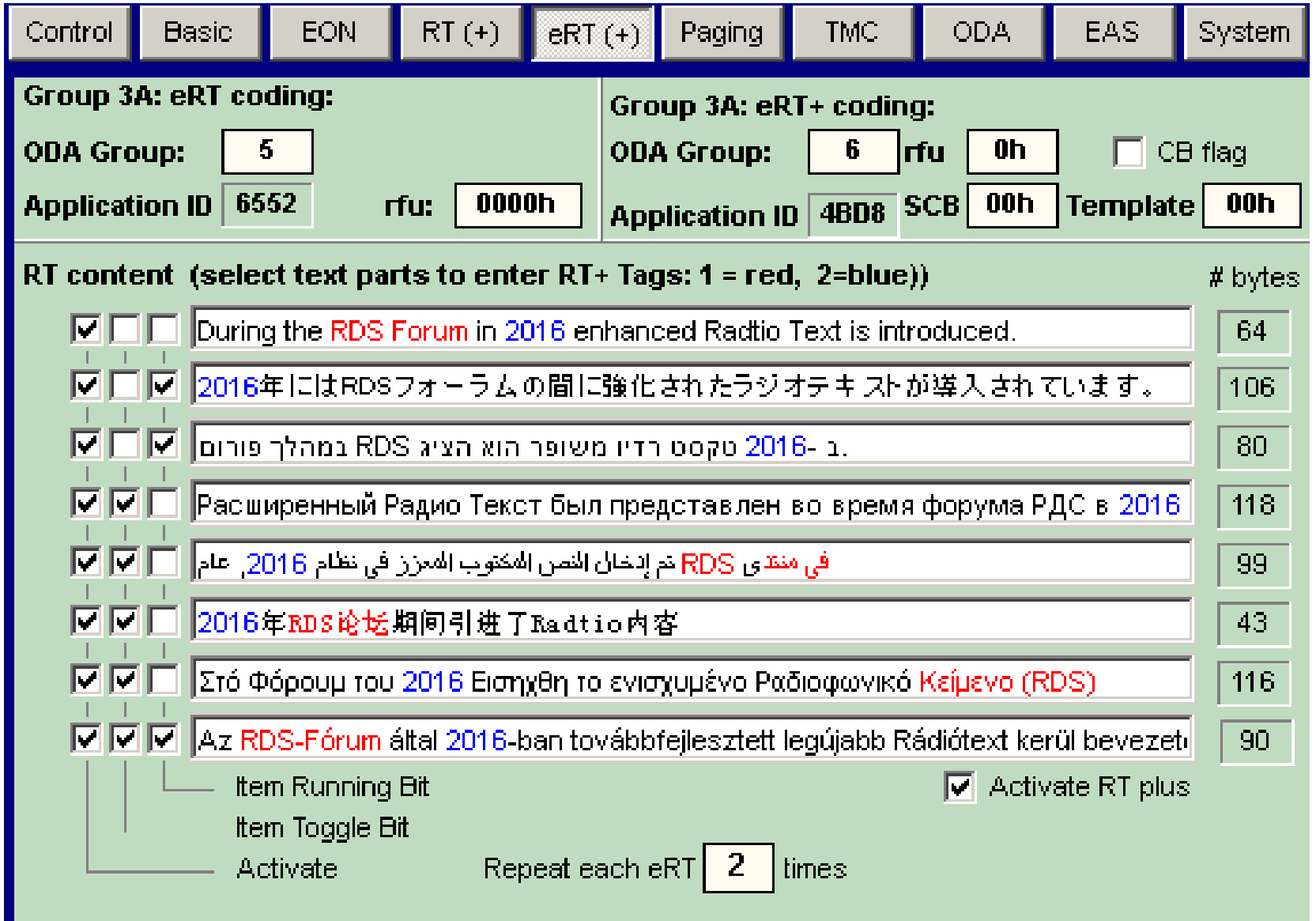


Figure 9 - 3: This is a screenshot from MacBe's TRX011 in TX mode. It can transmit eRT, UTF-8 coded, as shown by the various examples. eRT+ can be used as well to tag elements of the text: Red is used to mark Tag1 and blue is used to mark Tag 2.

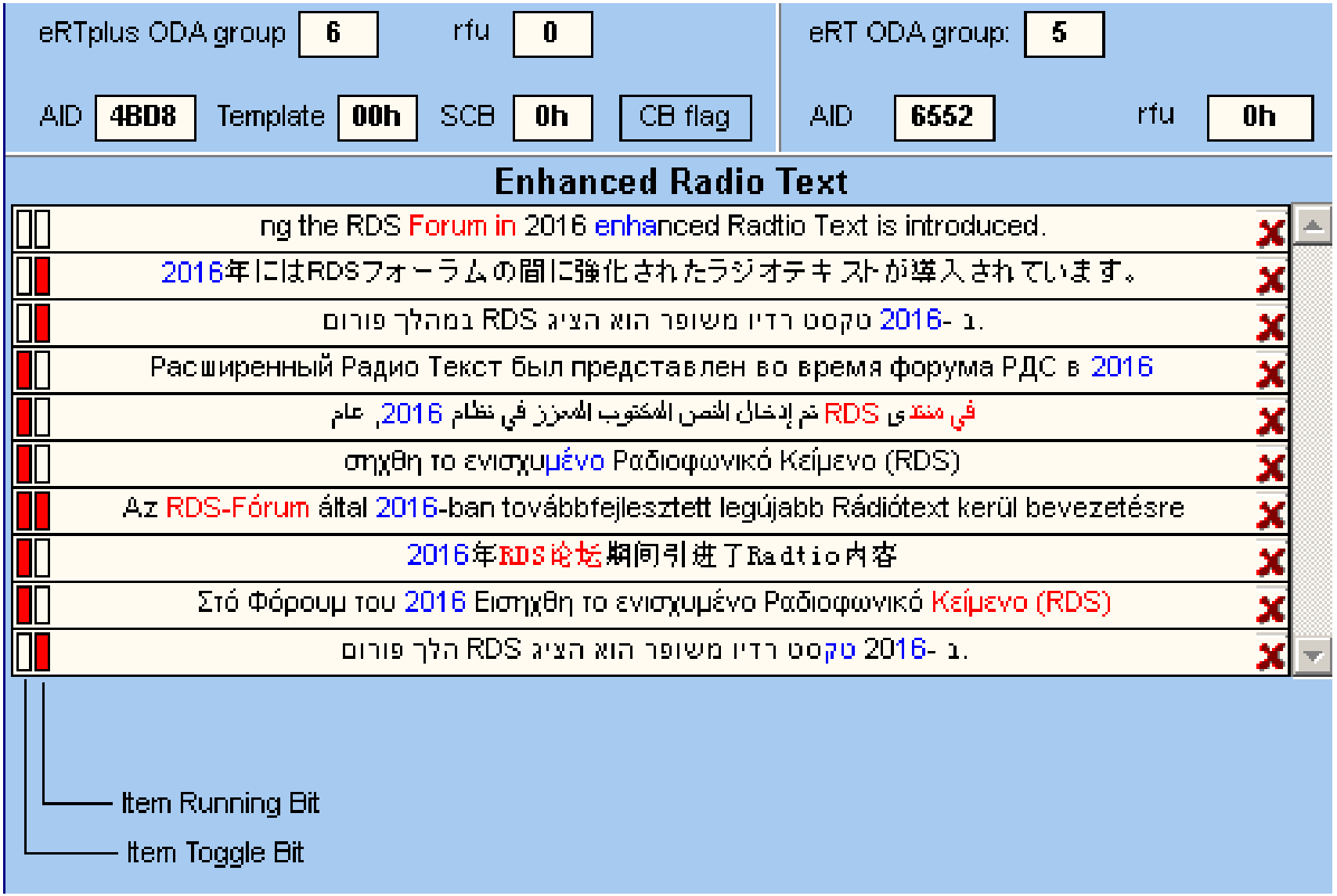
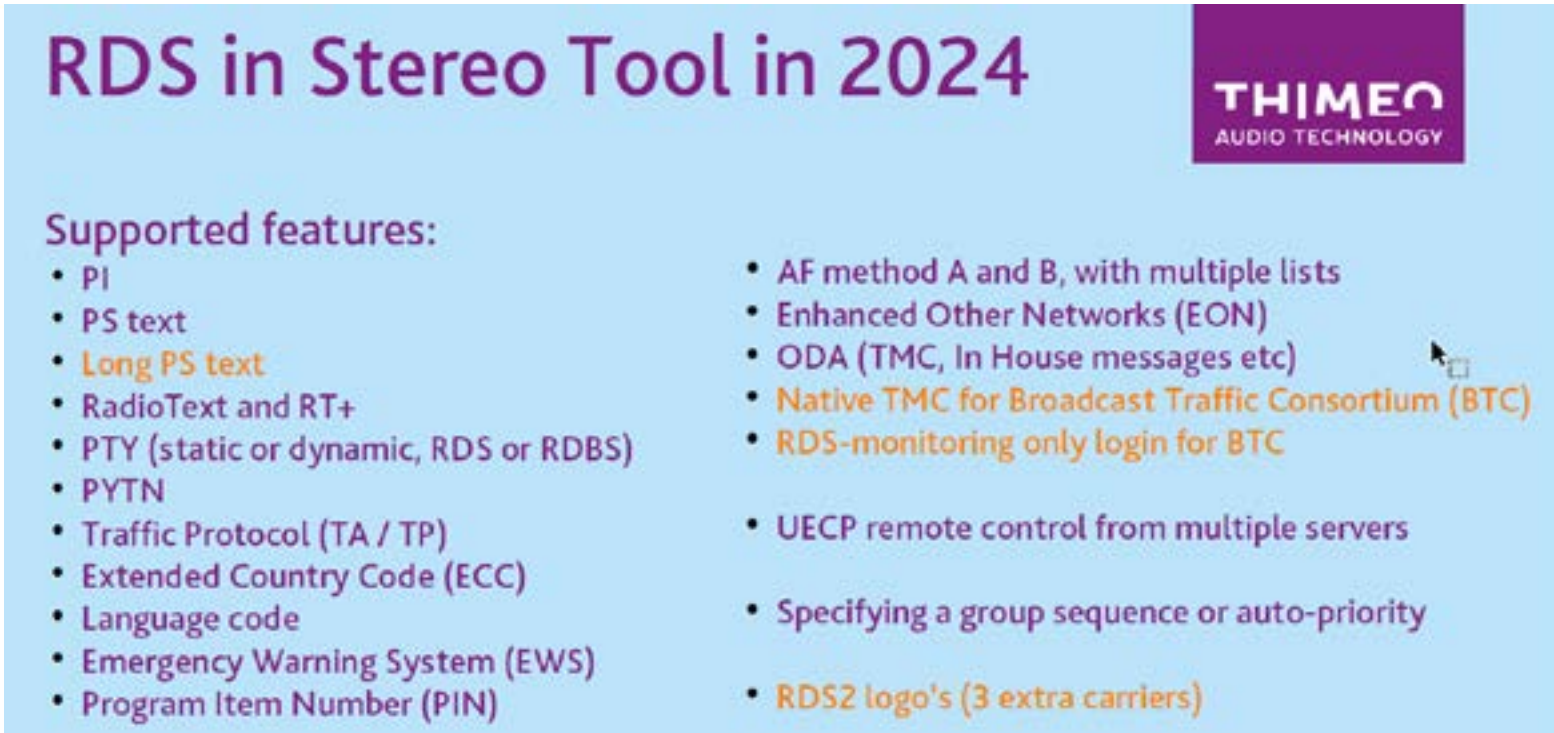


Figure 9 - 4: This is a screenshot from MacBe's TRX011 in RX mode. It can receive eRT and eRTplus, UTF-8 coded. The various examples shown on the previous page as transmitted with the TRX011 in TX mode are decoded and analysed in RX mode.



WCS - Worldcast Systems

WorldCast Systems is selling a software called APTmpX. This is an MPX/composite compression algorithm, described in more detail in the article about APTmpX v2 below from Hartmut Foerster. It is designed to reduce network bandwidth requirements while preserving a high quality audio in an MPX signal (with RDS, if required). This technology enables the transmission of the final MPX/composite signal at bitrates as low as 300, 400, 600 kbps, making it suitable for cost-effective IP connections. Regarding the different bit rates. The audio quality is best at 600 kbps (in theory). Listening tests have shown that the difference between 400 and 600kbps is not predictable. Even the 300 kbps is perceived to be superb. The main differences are: 300 kbps = 16 bit quantization and 400/600 kbps = 24 bit quantization. APTmpX v2 transports the full MPX signal with the RDS modulated 57 kHz subcarrier and there is no RDS data group generation within this software. So, all RDS content is transported transparently as delivered by the RDS source, either an RDS encoder or an appropriate audio processing software (such as that for the Omnia.9).

APTmpX v2

by Hartmut Foerster

Introduction

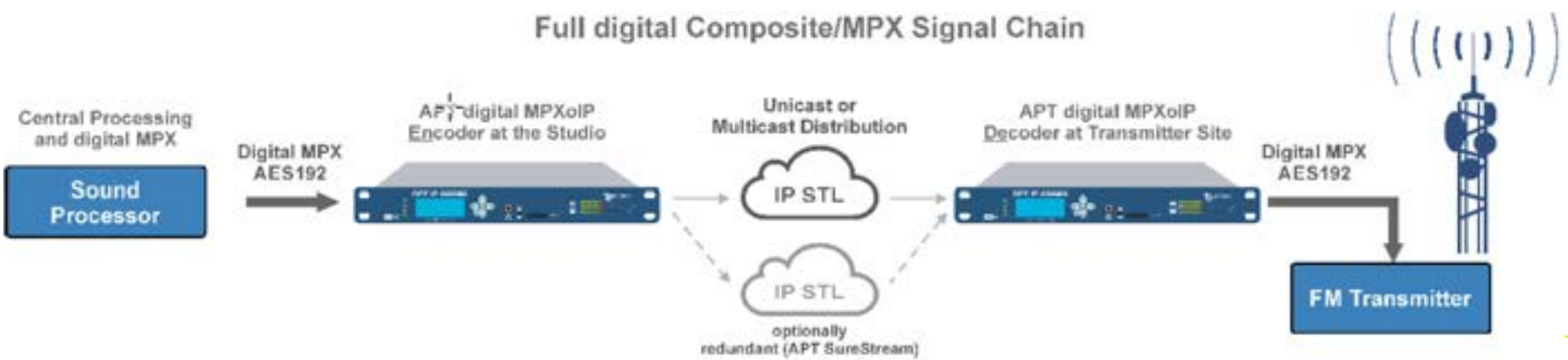
Did stereo FM give rise to the MPX signal, or was it the other way around? Either way, the multiplex (MPX) signal remains the essence of radio production, merging artistic and technical efforts into a single electrical signal.

Digitization revolutionized MPX processing with the AES192 format – the AES/EBU standard sampled at 192kHz. This allows the entire MPX spectrum, including RDS or RBDS data, to be transmitted digitally.

A key advantage of digital MPX transmission is centralizing signal processing in the studio. The sound processor, a costly but essential component, was often omitted at smaller transmission sites, leading to inconsistent audio quality. By keeping MPX processing in one location, broadcasters ensure a uniform and high-quality listening experience.

The digitalization of the MPX signal enables its uncomplicated and robust distribution in IP networks. The signal fidelity of the digital MPX remains undiminished at every transmitter location.

Really, at every location? What about the less essential locations that only have IP bandwidths suitable for baseband audio? Linear digital MPX in 24-bit resolution requires approximately 3.4Mbps for a single program and the RDS/RBDS signal. A high-quality audio signal (L/R) compressed with enhanced aptX (E-aptX) requires only about 420kbps (24Bit), including the embedded RDS/RDBS data. – Further innovation was required for a truly comprehensive MPX transmission.



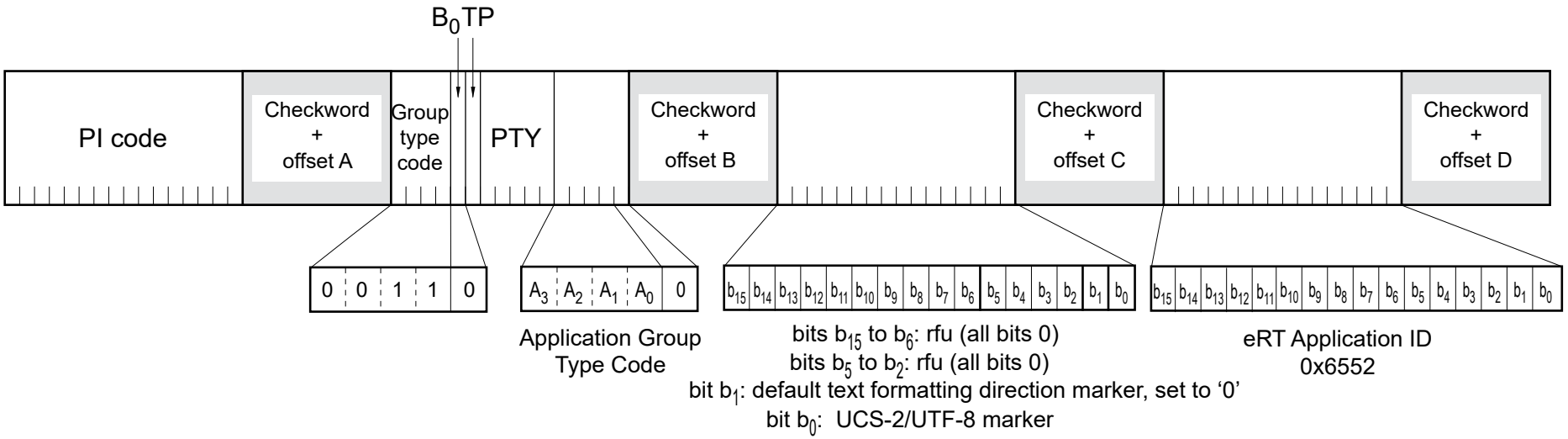


Figure 9 - 15 – Group type 3A: Application identification in block 4 and application group identification in block 2 and 16 bit of application data in block 3.

The meaning of the application data bits in block 3 of group type 3A is as follows.

a) Marker for UCS-2 /UTF-8 coding (bit b_0):

   Set to '0'– for UCS-2 encoding, or '1' for UTF-8 encoding. This option is no longer permitted to be used nowadays, but is kept for reasons of backwards compatibility with previous RDS standard versions.

   Set to '1' (now mandatory) – for UTF-8 encoding. The reason is that this has become the most popular character coding method on the Internet. Therefore, also with RDS we shall give this method now our preference so that we are future proof.

b) Marker for text formatting direction (bit b_1):

   Set to '0', which means transmission of the byte string is always from left to right.

c) Bits b_2 to b_5 are all set to '0' for the reason of backwards compatibility with the earlier eRT specification (rfu).

d) rfu – bits b_6 to b_{15} are all set to '0'.

Figure 9-16 shows the coding of message bits of the application group.

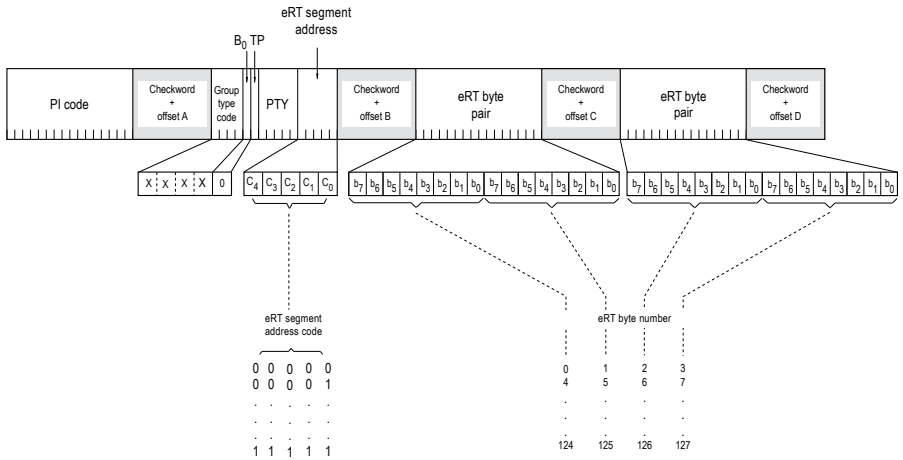


Figure 9 - 16 – Coding of the message bits of the application group type A.

The 5-bit segment address in block 2 defines the current byte number within the eRT text string, in terms of four bytes each, contained in the third and fourth blocks. The text string increases from left to right and the most significant byte is transmitted first.

A new text shall start with the segment address '00000' segment and there shall be no gaps up to the highest used segment address of the current message. The number of text segments is determined by the length of the message, and each message shall be ended by the control character 'carriage return' 0x0D, if the current message requires less than 128 bytes. The bytes left unused in the same segment address shall also be filled with 0x0D.

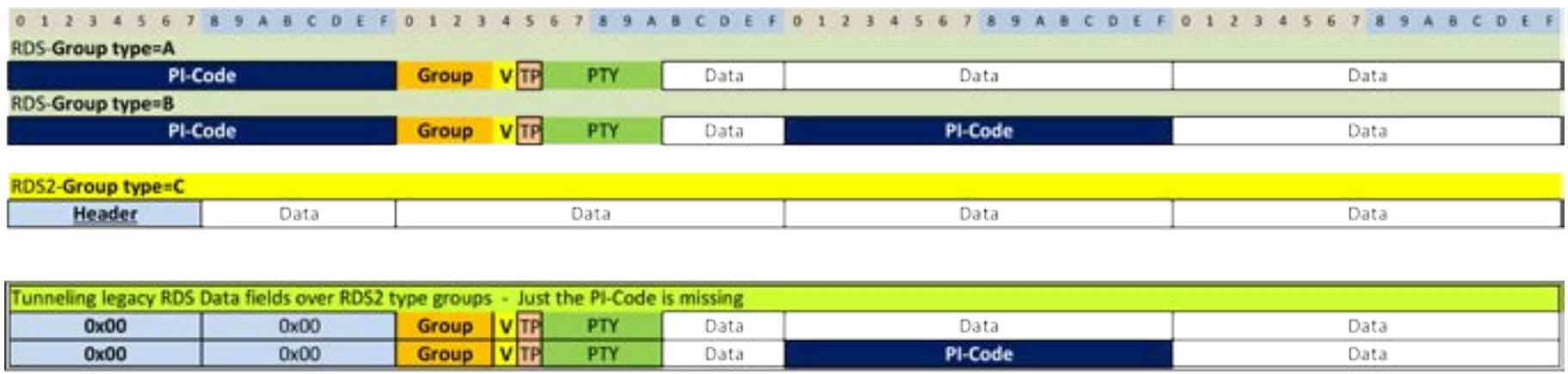
To ensure an enhanced RadioText message that is no longer valid is cleared from the display, the broadcaster should send a blank message only containing the 0x0D control character. The bytes left unused in the same segment address shall also be filled with 0x0D.

The toggle bit for changed text used in RT (group type 2A/B) is not used with eRT. The reason is that this toggle bit is not really required, because a change of text can easily be detected with the receiver's decoding software. The function of that toggle bit is to clear the text display for the new text to be shown. When a text change is detected, then the display has to be cleared to be ready to display the new text.

Tunnelling legacy RDS Data fields over RDS2 type groups on the upper RDS subcarriers

by Dietmar Kopitz

All legacy data and ODAs designed for data-stream 0, using group types 0 to 15 with versions A or B, can be transmitted using the upper data-streams 1 to 3, being tunnelled within group type C, which is the only group type that can be used on the upper data-streams. The method to be used is specified in IEC 62106-2. To achieve this, the RDS2 encoder replaces the two bytes of the PI code in block 1 of each A or B group by two bytes of 0x00 each. In doing so it encapsulates the data carried by legacy A and B type groups into C-type groups.



The C-type group structure used for tunnelling is shown above. You see, how the A-type (V=0) and B-type (V=1) groups are then mapped into C-type groups. In the decoding process the A- and B-type can be reconstructed, adding the PI code in Block 1.

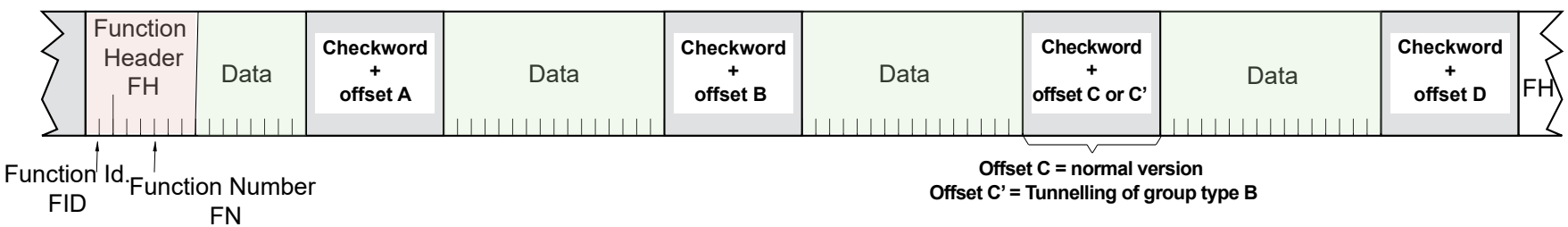
The upper subcarriers 1 to 3 can only use C-type groups. Tunnelling is an option where A or B type groups can be packed into C-type groups, so that ODAs designed for the basic subcarrier can be transmitted faster on the upper subcarriers. The tunnelling groups are identified by the two Function header FH bytes set to equal 0x00.

Open Data Applications ODA transmitted on the upper RDS subcarriers - Design principles

by Dietmar Kopitz

Introduction

The upper data streams are to be used exclusively for ODAs except for tunnelling, see above. For this purpose, a new group type C to be used on the upper subcarriers only, has been defined. Figure 9-17 shows the format of group type C. It can carry seven data bytes. One byte, the first one in block 1, is used to define the function of this group type. This first byte is called the Function Header FH and it is composed of two elements, the Function Identifier FID (2 bits) and the Function Number FN (6 bits). The public ODAs so far defined for RDS2 are all compiled in the RDS standard Part 6, IEC 62106-6. These are the ODAs for Station logo, Slideshow and Internet connection options.



NOTE 1: The Function Header (FH) is composed of a 2 bit Function id FID and a 6 bit Function number FN, and both together fully determine the function of the group.

NOTE 2: Offset word C' is only used for tunnelling B type groups.

Figure 9 - 17 – Group type C structure.

Functions of Group type C

There are in total four kind of group type C identifiers possible with the 2-bit FID. The group type C function identification is a combination of the 2bit-FID and the 6bit-FN. Four group type C function identifications are so far defined, see Fig. 9-18:

1. Groups used for tunnelling legacy group type A or B designed for subcarrier 0, FID=00 / FN=000000.

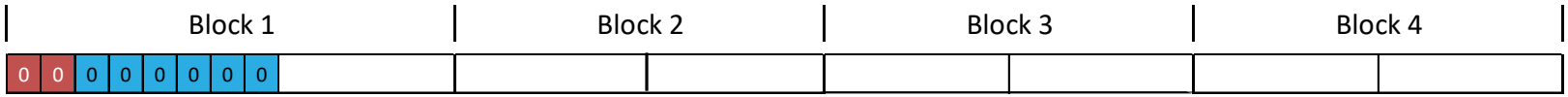
2. Groups used to carry the RDS2 ODA data in at max. 64 channels of which the first 16 ODA channels are reserved to carry additional file associated data using the same channel as a pipe for file transfer and if needed also other associated information, all with an FH composed of an FID=01 and a FN=yyyyyy, where FN is the respective channel number yyyyyy, 0 to 63 and where channels 0 to 15 are reserved for ODAs using files, even if these are used only occasionally.

3. Assignment groups that carry also some file associated ODA data, FID=10 / FN=000000. There exist four different assignment methods, see below in Table 1. But note this well, if an ODA uses a file or files to be transmitted with the RDS2 File Transfer protocol RFT (see below), then only the Method 1 assignment group with 16 variants (and of which variants 0 and 1 are already defined to be used with the RFT) is permitted be used.

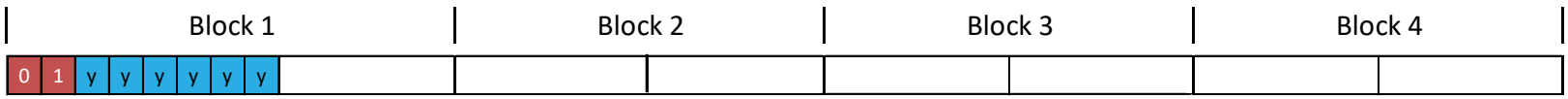
4. RTF groups that carry the file data, FH = (FID=00) + (FN=10yyyy) in at max.16 channels that become during the file transfer “pipes”. The “pipe” is thus embedded in an ODA channel. It is the RFT data stream that has to be accompanied by the Method 1 assignment group using the mandatory variants 0 and 1, if the latter is applicable. During the time when the channel serves as a pipe, only RFT data and the respective Method 1 assignment groups shall be transmitted. If the RFT data transmission is terminated, the channel can be used again for the transmission of associated ODA data groups and if there are none to be transmitted, the channel is used all the time as a pipe for the transmission of RFT data.

   When a file is transmitted the corresponding pipe has the same number, in the range 0 to 15, as the channel that carries the associated ODA data. The Method 1 assignment group variants 0 and 1 are to be transmitted in sync with their respective file (what is meant is during the time interval when the file is transmitted) and they must use variants 0 and 1 (if the latter is applicable).

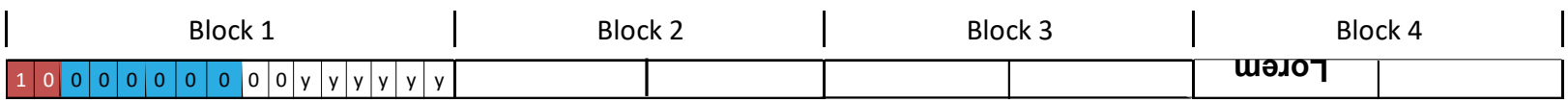
1. Group used for tunnelling of group type A or B designed for subcarrier 0:



2. Group used to carry the RDS2 ODA data in channel yyyyyy (0...63), if used with RFT only 00yyyy (1..15):



3. Method 1 assignment group that can also carry some ODA data:



4. RFT data group that carry the RFT file(s) data in pipe yyyy (0...15):

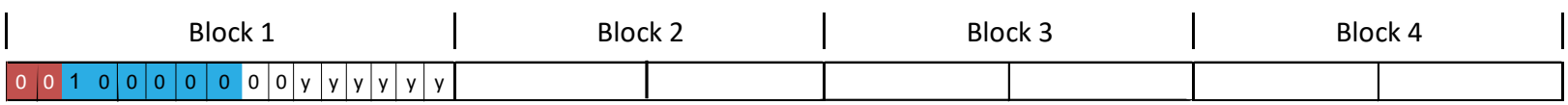


Figure 9 - 18 – Four different group type C identifications are used on the upper subcarriers.

Assignment groups that can carry also some ODA data

FID = 10 / FN = 000000

Across data-streams 1, 2 and 3 there are in total 64 channels. Four methods exist to assign AIDs to channel numbers, see Table 9-2 and Table 9-3.

Method 2, 3 or 4 from Table 9-3 all use successive channel numbers with an auto-increment function.

Table 9 - 2 – Group type C assignment methods used to connect channel numbers with one or more AIDs

Method	Function Header	Variant + Channel id.	AID connection with data channel
	Block 1		Blocks 2, 3 and 4
1	10 000000	00 yyyyyy	Connect data channel yyyyyy with a 16-bit ODA AID in block 2 and provide in addition four application data bytes in blocks 3 and 4.
2	10 000000	01 yyyyyy	Connect two successive data channels (yyyyyy and yyyyyy+1) with a 16-bit ODA AID in block 2 and a second ODA AID in block 4, respectively, and provide in addition two application data bytes in block 3 for the first ODA.
3	10 000000	10 yyyyyy	Connect two successive data channels (yyyyyy and yyyyyy+1) with a 16-bit ODA AID in block 2 and a second ODA-AID in block 3, respectively, and provide in addition two application data bytes in block 4 for the second ODA.
4	10 000000	11 yyyyyy	Connect three successive data channels (yyyyyy, yyyyyy+1 and yyyyyy+2) with a 16-bit ODA AID in block 2, a second ODA AID in block 3 and a third ODA AID in block 4, respectively.

Table 9 -3 shows the four methods described in Table 1 in more detail.Table 9 - 3 – Assignment of up to three successive channel numbers to multiple AIDs

Method	Block 1	Block 2	Block 3	Block 4
1	10 000000 00yyyyyy	AID	Data (for AID)	Data (for AID)
2	10 000000 01yyyyyy	AID1	Data (for AID1)	AID2
3	10 000000 10yyyyyy	AID1	AID2	Data (for AID2)
4	10 000000 11yyyyyy	AID1	AID2	AID3

EXAMPLE: When using method 4 in and yyyyyy equals 16 then AID1 is connected with channel 16, AID2 with channel 17 and AID3 with channel 18.

NOTE: For ODAs with files, even only occasional ones, using one of the channels in the range 0 to 15, the assignment method 1 is the only one applicable and assignment methods 2 to 4 cannot be used here.

An ODA that requires additional associated file data transferred using the RFT protocol (see below), uses only method 1 assignment groups. Since the channel number equals the pipe number, the channel number is implicitly determined through the pipe number, which is assigned in every method 1 assignment group. Should the file being transferred need additional file data in the definition phase then, like the data in the C-block of the 3A group with RDS on subcarrier 0, one or more variants in the range 2 to 15 of the method 1 assignment group may be used. However, during the file transfer interval the variants 0 and 1 (if applicable) of the method 1 assignment group will be mandatory, but not exclusive. The general concept is that each pipe carries the data of a file or a sequence of files and its file data in those variants 0 and 1. Variant 1 is applicable only if a CRC-16 is used for the file transfer.

RDS2 file transfer RFT using a pipe in the range 0 to 15

The RDS2 file transfer protocol RFT is designed for the transport layer. There are some important objectives to be achieved for receivers:

a. Be able to quickly identify the AID.

b. After identification it is known whether the specific AID is supported or not.

c. No buffers to be reserved for not supported AIDs.

d. Being able to assemble a file even when groups go missing using the repetitions.

e. Use a toggle bit to avoid mixing groups from different files.

f. Make the file transfer independent of its content, i.e. the file type.

The receiver should be able to assemble a file even when a single group or a several groups go missing, because it can be received later during the repetitions without requiring the groups before or after to be received correctly. Instead of a requirement to receive a sequence of groups with no errors, the RFT allows for a single group to be restored later, if it was dropped earlier in the transmission.

Pipes are used for the file transfer. The channel number (range 0-15) of the ODA is same number as the pipe number in which a file belonging to the respective ODA is transferred, the pipe being then a transformation of a channel during the RFT file transfer process:

- 16 pipes are reserved to transfer files.
- One pipe serves only one ODA and its specific file or files.
- The file transfer pipe and its ODA channel are signalled by the method 1 assignment group, variant 0 -15 with variant 0 and 1 being mandatory during the file transfer interval and in sync with the file sequence.
- Variant 0 contains the information describing the file being transfered.
- Variant 1 is to be used only in case a CRC is needed for the file transfer.
- Variants 2 to 15 of the method 1 assignment group are free to be defined by the ODA design process and they shall be used only when ODA data use the respective channel.

Variant 0 is used to describe the file in terms of file id (6 bits), file version (3bits) and file size (18 bits). An additional bit indicates whether a CRC-16 is used, or not. All 16 possible method 1 assignment group variants are shown in Figures 9-19a, b and c.

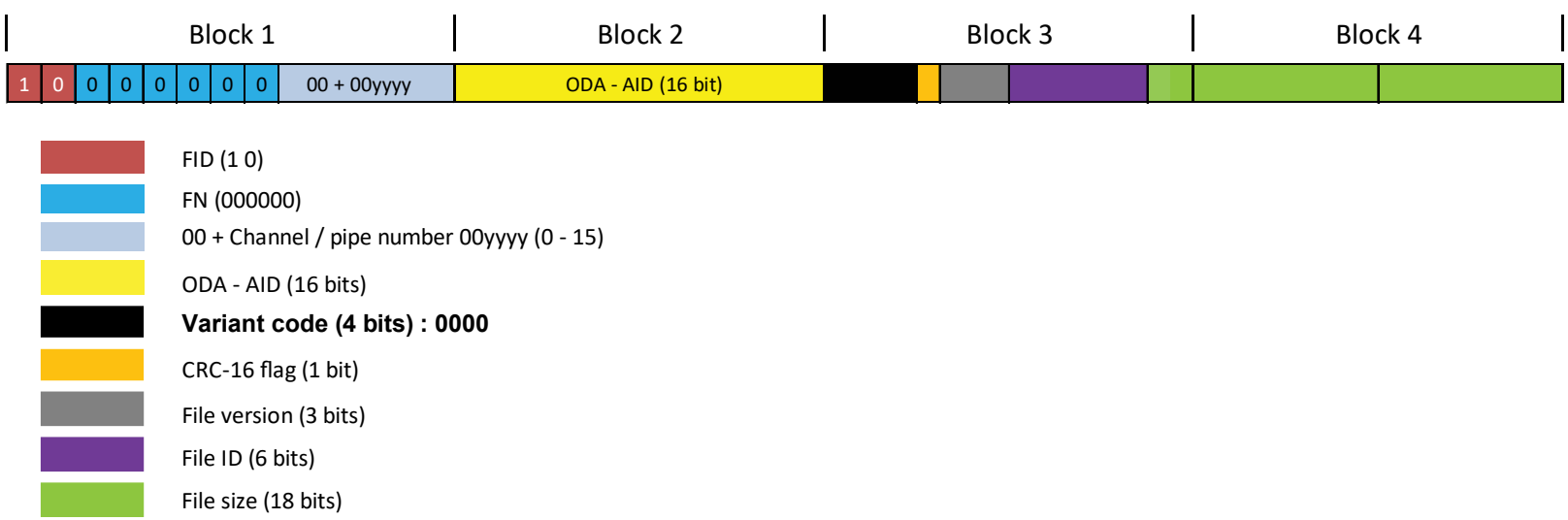


Figure 9 - 19a – Method 1 assignment group variant 0 is used to describe the file.

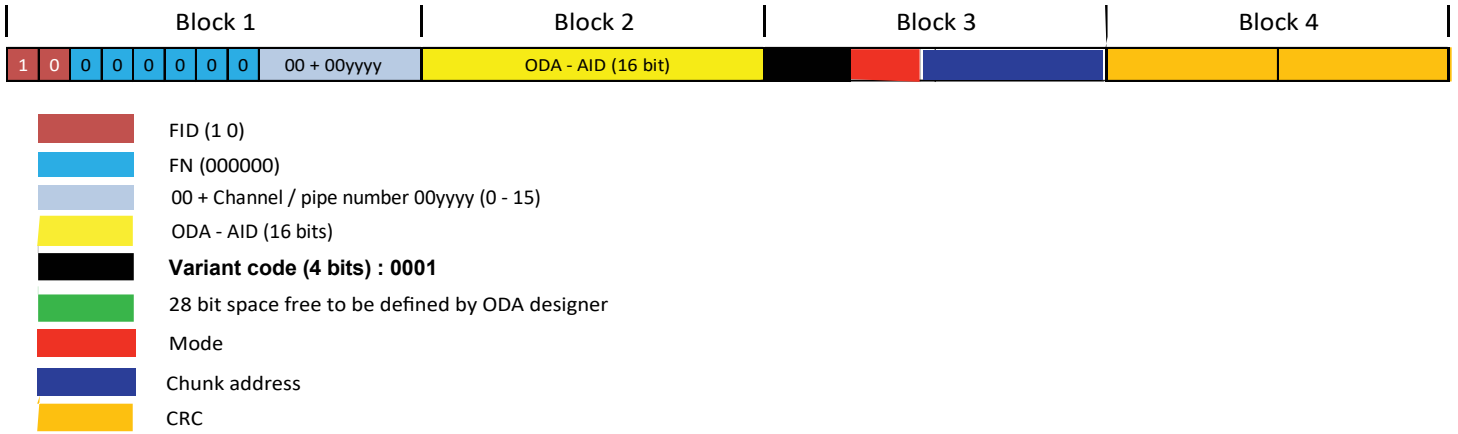


Figure 19b – Method 1 assignment group variant 1 is only used by the RFT protocol when a CRC is used for the file transfer.

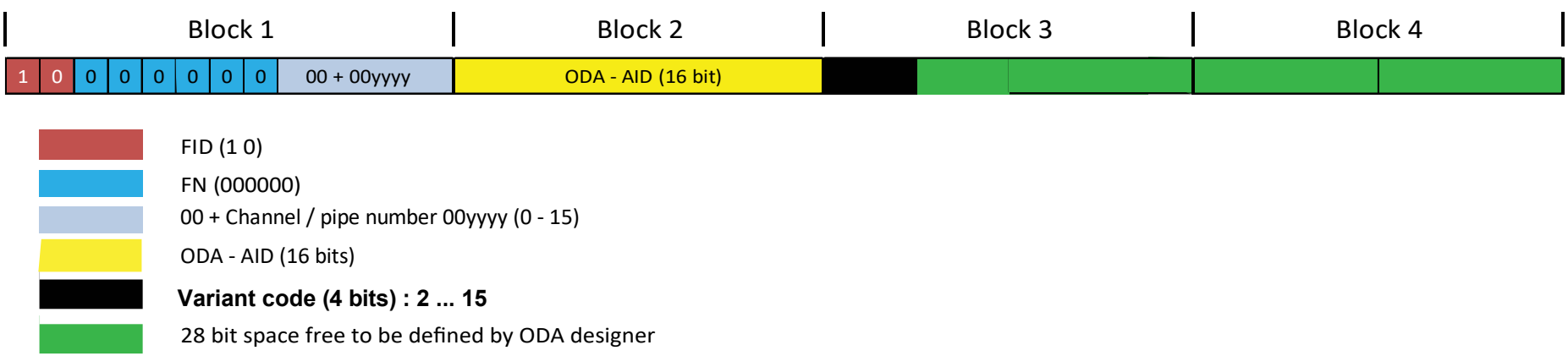


Figure 19c – Method 1 assignment group variants 2 to 15 can be used by the ODA protocol to carry on the respective channel additional ODA data.

Variants 2 to 15 are an option that the ODA designer can use to transfer additional ODA data.

Channel used to carry ODA data associated with a file, or not

FID = 01 / FN = yyyyyy (channels 0 … 63)

This Function Header allows group type C ODA data to be sent using channel yyyyyy (0 …63) indicated by the 6 bits of FN, 64 channels in total using one of data-streams 1, 2 and 3 or all.

Channels 0 to 15 are reserved for ODAs using files and they can be assigned only with the method 1 assignment method.

The ODA application data content is 7 bytes. However, to be able to transfer a large sequence of data bytes, it is common practice to design the protocol using variants. These may be and are often coded using the most significant 4 or more bits, as would be required by the ODA design process and the choice to be made is free.

The channel number associates the remaining 6.5 bytes (or less) of data with a particular AID of a group type C ODA, signalled by the method 1 assignment group using variants 2 to 15. This is a similar association as the one used, with group 3A, between the group number and a particular AID of a legacy group type A or B ODA in data-stream 0.

If the respective ODA requires a file or files to be transferred, channels 0 to 15 are to be used as described above for the RFT. Then the ODA data channel number is the same as the pipe number of the file being transferred and it is always in the range 0 to 15.

Channels 16 to 63 are for ODAs using no files. They can use for the channel assignment method 1, 2, 3 or 4.

For group type C ODAs the channel number is assigned to an AID as shown above in Table 1.

It is the transmission operator, or the broadcaster concerned who decides which channel is used for an ODA.

Summary of the above principles

Only method 1 assignment group will be used for ODAs with files.

- In case of an ODA without files: The ODA blocks 3 and 4 are fully available for ODA data (32 bits).
- In case of an ODA without files: The ODA channel range is limited to 16..63.
- In case of an ODA with files: block 3 of the method 1 assignment group starts with a 4-bit variant; the remainder is available for ODA data (28 bits) (and only variants 2 to 15, as variants 0 and 1 are already defined and must be used in sync with the respective file being transfered with the RFT file data transmitted in sequence.
- In case of ODA with files: The channel/pipe range is limited to 0..15.

The channel and pipe assignment groups are:

MSB in Block 1			
FID	**FN**	**Function**	**LSB in Block 1**
10	000000	ODA assignment for an application with files	0000yyyy (only 0 to 15)
10	000000	ODA assignment for an application without files	00yyyyyy (only 16 to 63)

Note: LSB is the least significant byte

The data groups are:

MSB in Block 1			
FID	**FN**	**Function**	**LSB in Block 1**
00	000000	Legacy data being tunneled	00000000

00	10yyyy	Pipe in range 0 to 15: RFT file with or without additional ODA data	data
01	00yyyy	Same channel no. as pipe: Additional ODA data for file	data
01	yyyyyy	Channel 16 to 63: ODA data for apps without a file	data

Possibilities to trigger the information to be shown on the display

A short signal, i.e. a burst of the group carrying this information, repeated few times and spaced with other groups transmitted in between, would be needed to trigger the information carried in the file and/or the associated data to be shown on the display. An example is the display of music cover art, which has to be transmitted before the respective music item will be played in the radio programme. This is because the music cover art file transfer will take two minutes or more.

Several possibilities exist, assuming that only a few bits will be needed to signal the link to the current image to be made:

1. One can use on the basic carrier a short sequence, a burst, of 3A groups with the application group code 0000 which has the special meaning that no application group type is associated on the basic subcarrier. The 16-bit application data in block 3 can carry the necessary information for the respective link for the cover art file concerned to be made. The AID to be used shall be the same as that of the application which transfers the music cover art with C-groups on the upper subcarriers. However, the UECP, as defined so far, does not permit to create such a burst.

2. One can use a burst an A or B type ODA group on the basic subcarrier. The A-type group permits to code 37 bits for this purpose and the B-type group 21 bits.

3. Or, on the upper subcarriers a burst with the variant code in the range 2 to 15 from the method 1 assignment group may be used. Such a variant can use up to 28 bits for defining the link to be made.

4. Or, on the upper subcarriers a burst of a RFT associated ODA group, to be defined for this purpose, may be used.

Example: Coding of a fictive ODA called “Image with Text”

AID=???? (this is a fictive value, as this ODA-AID we would need for this example is not assigned).

The respective image is transferred with the RFT group. The UTF-8 coded text, we consider here, is attached to the respective image. The image is transmitted first, followed by the text that belongs to it.

The text is structured using eight text fields or levels, called “Text type” 0 …7, as follows:

0. Level 0 / Title 1: Up to 64 bytes
1. Level 1 / Title 2: Up to 128 bytes
2. Level 2 / Header: Up to 256 bytes
3. Level 3 / Long text: Up to 5120 bytes (Text segment counter 0 …1024 / 10 bits)
4. Level 4 / URL 1: Up to 256 bytes
5. Level 5 /URL 2: Up to 256 bytes
6. Level 6 / URL 3: Up to 256 bytes
7. rfu - reserved for future use

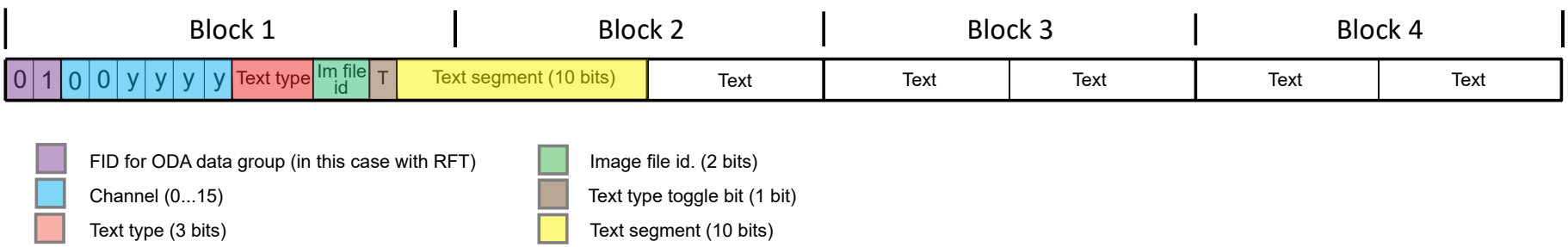


Figure 9 - 22 shows the coding of the text elements sent with the image; for the text transmission the associated ODA group is used that uses the same channel as the pipe used for the image transmission by means of the RFT.

In the example shown in Figure 9-22 we use 3 bits for the image file identification. This is to ensure that when the respective text fields are updated, they remain associated to the correct image file. In this example, the 3 bits permit to use a sequence of up to eight images to be placed on the carousel.

Which of the eight images with its respective text shall be shown on the receiver’s display is to be determined by a trigger signal of which the details are not described here. To achieve this, a burst of an assignment group variant in the range 2 to 15 can be defined and used at the instant required.

We also use in Figure 9-22 a toggle bit T. As each text field can be updated when needed, the toggle bit changes when the content of the respective text field has changed. In that case, before the new text version is entered into the respective text buffer, and replaces the old text which is flushed.

To ensure correct reception of the image files and respective text fields, they shall be repeated at least twice and even better three times. When the receiver is switched off, all content in the respective buffers shall be flushed. This is to avoid that when the receiver is switched on again, outdated information is shown on the receiver's display.

Figure 9-23 shows a typical screen for this kind of application.



Figure 9 - 23 - Example, from an ongoing Radio France project, testing an image with associated text information.

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ODA app for RDS2 - Slideshow transmission coded in C-group type

The app in IEC 62106-2 Ed 2 (2023), Annex F, applies the coding principles explained above. For details of the coding refer to this IEC standard.

With this Slideshow app the following objectives can be achieved using a carousel of up to 16 slides.

- Broadcasting of slides which are programme related, or not;
- A slide can contain an image and text components (all are optional);
- The text consists of structured text components to inform the receiver what kind of text it is;
- Some text components consist of text elements grouped together (as Preview and as URLs);
- Two next slides can be broadcast in advance to inform receivers what is coming next;
- The display by the receiver of the current slide can be synchronized with the audio using a directory trigger group (e.g. for music cover art);
- The directory trigger group signals three slides (current, next, 2nd next);
- The image and all text components can be updated independent of each other.

Several use cases can be covered:

a) Non-programme related where the broadcaster does not know what comes next (e.g. sport).
b) Programme related when the broadcaster knows what comes next (e.g. music play list).
c) Non-programme related Slideshow where a carousel cycles several slides (advertisements or sequence of news items).

Application identification code of this ODA

The AID code of this ODA is 0xFF80.

Image requirements

File type

Either jpg or png shall be used as File type. No file type identifier is needed as all file relevant info, including the file type, is already embedded in the file header of each of those formats.

Aspect ratios, resolution and file size

The required image resolution is expressed in pixels for the width and height. Two aspect ratios are possible: 240 x 240 px or 320 x 240 px.

Images not existing in this resolution will need to be re-scaled for transmission by the transmission operator or broadcaster.

Emergency warning messages with related instructions must be constantly available, also when local infrastructure with power-supply is out of operation.
Messages must cover the whole of the affected area and the direct adjacent areas as well.



Implementation in RDS

The RDS specification has several options to send and signal alert messages in a timely and reliable way to a large number of people in an affected area. PTY 31 is the most useful tool for this and PTY 30 can be used to test that functionality.
PTY 31 has been specified from the beginning for alarm and emergency messages. With the EON feature, PTY 31 on a given radio programme can be signalled from other radio programmes within the same radio programme network, to ensure instant switching to the relevant radio programme carrying the alert messages. When PTY 31 is set to ON by the broadcaster, a cross-reference data burst is sent and signalled from the other programmes pointing to the programme which is assigned to deliver the emergency messages. With one single trigger, the broadcaster can thus reach a massive amount of people in a reliable way to be directed to the relevant programme for further information and instructions.
The information is generally to be spoken. The alert warning is constantly repeated and preferably supported by a visual display text information. With RDS several different possibilities of using RadioText (RT/RT+) exist. An obvious choice is

- RT+ with RT content type 27 (INFO.ALARM), see the image below. RT/RT+ can also cross-reference to more detailed information on the Internet with RT content type 29 (INFO.URL)



Extreme cold weather alert using for display RT/RT+ with type 27 (INFO.ALARM)

Up-dates can be communicated by general RadioText RT as a continuing message carousel.

This eBook was written by a team of RDS Forum members who are closely involved in the RDS development since more than 30 years. Thus this book comprises an enormous amount of collective knowledge and information. It generally informs the reader about the possibilities seen now, within the RDS Forum, to use this well proven and much updated FM radio technology at its very best, well taking into account the transition to digital radio in Europe and the USA. This book gives an overview on the history of the RDS technology, describes generally the RDS system and all RDS features, explains the UECP and why it is needed. It also explains how to monitor and generate RDS signals on air, RDS in the world of automotive applications, the fundamental principles of RDS-TMC, the possibility to extend RDS and makes a prediction of the future use of FM radio and RDS2.

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