ETSI TS 102 386 V1.2.1 (2006-03)

Technical Specification

Digital Radio Mondiale (DRM); AM signalling system (AMSS)

European Broadcasting Union

Union Européenne de Radio-Télévision

EBU·UER

Reference

RTS/JTC-DRM-16

Keywords

broadcasting, digital, DRM, radio, AM

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Foreword

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NOTE: The EBU/ETSI JTC Broadcast was established in 1990 to co-ordinate the drafting of standards in the specific field of broadcasting and related fields. Since 1995 the JTC Broadcast became a tripartite body by including in the Memorandum of Understanding also CENELEC, which is responsible for the standardization of radio and television receivers. The EBU is a professional association of broadcasting organizations whose work includes the co-ordination of its members' activities in the technical, legal, programme-making and programme-exchange domains. The EBU has active members in about 60 countries in the European broadcasting area; its headquarters is in Geneva.

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Introduction

The frequency bands used for broadcasting below 30 MHz are:

- Low Frequency (LF) band: from 148,5 kHz to 283,5 kHz, in ITU Region 1 [1] only;
- Medium Frequency (MF) band: from 526,5 kHz to 1 606,5 kHz, in ITU Regions 1 [1] and 3 [1] and from 525 kHz to 1 705 kHz in ITU Region 2 [1];
- High Frequency (HF) bands: a set of individual broadcasting bands in the frequency range 2,3 MHz to 27 MHz, generally available on a Worldwide basis.

These bands offer unique propagation capabilities that permit the achievement of:

- large coverage areas, whose size and location may be dependent upon the time of day, season of the year or period in the (approximately) 11 year sunspot cycle;
- portable and mobile reception with relatively little impairment caused by the environment surrounding the receiver.

There is thus a desire to continue broadcasting in these bands, perhaps especially in the case of international broadcasting where the HF bands offer the only reception possibilities which do not also involve the use of local repeater stations.

However, broadcasting services in these bands:

- use analogue techniques;
- are subject to limited quality;
- are subject to considerable interference as a result of the long-distance propagation mechanisms which prevail in this part of the frequency spectrum and the large number of users.

As a direct result of the above considerations, there is a desire to effect a transfer to digital transmission and reception techniques in order to provide the increase in quality which is needed to retain listeners who, increasingly, have a wide variety of other programme reception media possibilities, usually already offering higher quality and reliability.

In order to meet the need for a digital transmission system suitable for use in all of the bands below 30 MHz, the Digital Radio Mondiale (DRM) consortium was formed in early 1998. The DRM consortium is a non-profit making body which seeks to develop and promote the use of the DRM system worldwide. Its members include broadcasters, network providers, receiver and transmitter manufacturers and research institutes. More information is available from their website (http://www.drm.org/).

1 Scope

The present document defines a system for adding a limited amount of service information to analogue broadcasts in the frequency bands below 30 MHz in a complementary way to the Digital Radio Mondiale (DRM) system. It is intended to be used by broadcasters in the transition to all digital transmission by providing labelling and frequency information for a better user experience.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

[1] ETSI ES 201 980: "Digital Radio Mondiale (DRM); System specification".

[2] ITU-R Recommendation BS.706: "Data system in monophonic AM sound broadcasting: (AMDS)".

[3] CENELEC EN 62106: "Specification of the radio data system (RDS) for VHF/FM sound broadcasting in the frequency range from 87,5 to 108,0 MHz".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

reserved for future addition (rfa): bits with this designation shall be set to zero

NOTE: Receivers shall ignore these bits.

reserved for future use (rfu): bits with this designation shall be set to zero

NOTE: Receivers shall check that these bits are zero in order to determine the valid status of the other fields in the same scope.

Service Description Channel (SDC): channel of the multiplex data stream which gives information to decode the services included in the multiplex

NOTE: The SDC also provides additional information to enable a receiver to find alternative sources of the same data.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AM	Amplitude Modulation
AMDS	Amplitude Modulation Data System
AMSS	AM Signalling System
CRC	Cyclic Redundancy Check
DRM	Digital Radio Mondiale
FAC	Fast Access Channel
HF	High Frequency
LF	Low Frequency
LSb	Least Significant bit
MF	Medium Frequency
MSb	Most Significant bit
rfa	reserved for future addition
rfu	reserved for future use
SDC	Service Description Channel

4 General

Digital Radio Mondiale (DRM) provides a system for digital transmission in the broadcasting bands below 30 MHz. These bands are also used globally for analogue broadcasting and many hundreds of millions of listeners regularly tune in. The transition from the analogue to the digital world requires careful planning by broadcasters so as to move at the speed of their audiences. The AM signalling system specified in the present document provides a tool for easing the transition from analogue to digital. It allows limited additional service information features to be provided to analogue listeners (for example, assisted re-tuning) in order to give them a taste of the full enhancements provided by digital broadcasting (for example, greatly improved audio quality). Further, it assists DRM receivers equipped with AM decoders with AMSS to find DRM transmissions of the same service in the same area or when the receiver is moved to a new area.

The AM signalling system makes use of the service information signalling from DRM's SDC to reduce the complexity of the database management in combined DRM/AM receivers and the coding and modulation basis of the AMDS system specified in ITU-R Recommendation BS.706 [2].

The AM signalling system uses phase modulation of the AM carrier to provide a low data rate digital signal path from broadcaster to receiver. The modulation scheme parameters are chosen so as to provide this data path without causing obtrusive impairment to the audio. Error control mechanisms are included in the baseband coding scheme.

5 Service information

5.1 Introduction

This clause describes the format and content of the service information provided by the system. To allow simple decoding of data in a combined DRM/AM receiver, the DRM SDC [1] is used as the coding mechanism, although certain restrictions apply.

Two data blocks are transmitted alternately to provide fast identification of the broadcast and service information to enhance the listener's experience. Each data block has a payload of 36 data bits.

5.2 Use of SDC data entities

The SDC data entities specified for DRM (see ES 201 980 [1], clause 6.3) provide many features. Some of these are not required for AM services. Furthermore, DRM can transport up to four services in a multiplex (audio or data), whereas AM carries only one audio service. The following restrictions and rules apply to the use of the SDC data entities.

5.2.1 Permitted SDC data entities

Table 1 lists the data entities that are permitted to be carried.

Table 1: SDC data entity usage

Data entity	Name	Permitted?
0	Multiplex description	No
1	Label	Yes
2	Conditional Access Parameters	No
3	AFS - Multiple frequency network information	No
4	AFS - Schedule definition	Yes
5	Application information	No
6	Announcement support and switching	Yes
7	AFS - Region definition	Yes
8	Time and date information	Yes
9	Audio information	No
10	FAC channel parameters	No
11	AFS - Other services	Yes
12	Language and country	Yes

5.2.2 Usage rules for SDC data entities

The Short Id field shall always be set to "00" and refers to the service identifier carried in each AM signalling group.

5.3 Structure

To allow fast identification of the broadcast, the service identifier is provided in every AM signalling group. In addition, service information, coded as SDC data entities, can be transported using an addressed segmentation system that permits an efficient error control mechanism. The AM signalling group is divided into two blocks, called block 1 and block 2 (see clause 6).

5.3.1 Segmentation

SDC data entities may be sent singly or aggregated together. Padding bytes are added if the overall data length is not a multiple of four bytes minus two. A CRC is calculated over the SDC data entities and padding (if present) and appended to form the data entity group (see ES 201 980 [1], annex D). The maximum overall length of the data entity group is 64 bytes. The data entity group is divided into a series of 4-byte segments. Figure 1 shows this process.

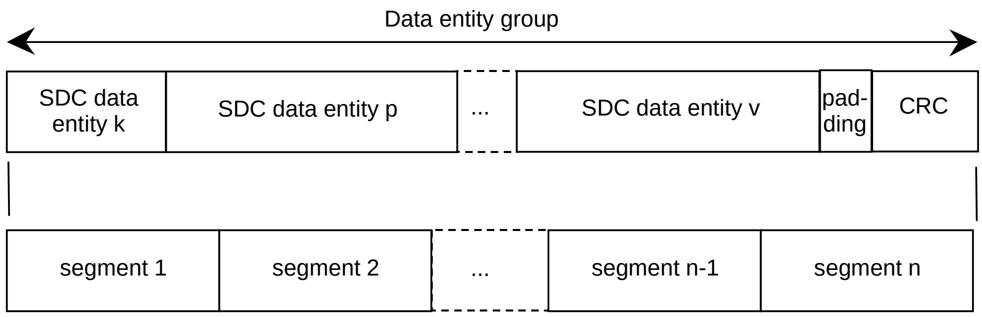

Figure 1: Segmentation scheme

The **SDC data entity** fields shall contain one of the permitted SDC data entities given in table 1.

The **padding** field shall be of length 0 bytes to 3 bytes and shall contain bytes of value 0x00.

The **CRC** (Cyclic Redundancy Check) field shall contain a 16-bit CRC calculated over the SDC data entities fields and the padding field. It shall use the generator polynomial $G_{16}(x) = x^{16} + x^{12} + x^5 + 1$. See ES 201 980 [1], annex D.

NOTE: The calculation of the CRC differs from DRM because the AFS index is not included and padding could be required.

The **data entity group** is divided into a number of segments (between 1 and 16), each 4 bytes long.

5.3.2 Block 1 coding

This block allows for identification of the service and indicates the size of the data entity group transported in block 2. The information is as follows:

- Version flag 1 bit.
- AM carrier mode 3 bits.
- Number of segments 4 bits.
- Language 4 bits.
- Service identifier 24 bits.

The following definitions apply:

Version flag: this flag changes state whenever the contents of the data entity group carried in block 2 changes. It indicates to the receiver that new information is available.

AM carrier mode: this field shall be used to signal any dynamic carrier processing which is being applied to the transmission currently received according to table 2.

Number of segments: this field gives the total number of data segments minus 1 (range of 1 to 16 segments; 4 bytes to 64 bytes of data) used to carry the data entity group transported in block 2.

Language: this field gives the language of the service according to the language table in DRM (see ES 201 980 [1], clause 6.3.4).

Service identifier: this field gives the service identifier for this service. AM and DRM services with the same content should have the same service identifier.

Table 2: AM carrier mode

AM carrier mode			Language
0	0	0	"Normal" AM: no carrier control
0	1	0	AMC mode 1 (3 dB carrier reduction)
0	1	1	AMC mode 2 (6 dB carrier reduction)
1	0	0	DAM mode 1 (3 dB carrier enhance)
1	0	1	DAM mode 2 (6 dB carrier enhance)
0	0	1	reserved
1	1	0	reserved
1	1	1	reserved

5.3.3 Block 2 coding

This block carries the SDC data entities. The information is as follows:

- Segment address 4 bits.
- Data segment 32 bits.

The following definitions apply:

Segment address: this field gives the address of the segment carried in this block 2 (range 0 to 15). Segment 0 is the start of the data entity group.

Segment: this field contains one segment (4 bytes of the data entity group) indexed by the segment address.

5.4 Repetition and decoding issues

The addressed segmentation system allows the receiver to build up the data entity group segment by segment. The total number of segments is signalled in block 1, and the segment address is sent with each segment in block 2. Once the block decoder has provided a corrected block 2, the segment can be placed into its correct place. When all segments have been collected the overall CRC shall be checked to ensure that the segments are all from the same data entity group. The receiver can then watch the version flag to determine when a new data entity group is being transmitted.

NOTE: After a long period of errors, the receiver may have missed a double change to the version flag. In this case it could be building up segments from more than one data entity group. The receiver should check the number of segments field in block 1. If these disagree then the existing data entity group should be discarded and the process restarted. If the number of segments is the same, then the receiver should continue to add segments and check the CRC after each segment is added. When the CRC is correct, a complete set of segments from the same data entity group will have been received.

When the version flag changes state, the receiver begins to build up a new data entity group, segment by segment. All existing data entity group segments shall be discarded. Once complete, this new data entity group may be passed to the SDC decoder.

A broadcaster may choose to send his service information in one or more data entity groups dependant upon his requirements. The overall amount of data may be more than 62 bytes, in which case more than one data entity group is required, or it may be that there is some time sensitive data (for example announcement switching) which needs minimum transit delay. This data should be carried in short data entity groups so that only a small number of segments need to be received before the SDC data entities can be passed onto the decoder.

The repetition strategy of the broadcaster needs to be carefully considered, and should be based on the likely error performance of the r.f. channel that the transmission will use. For LF and MF channels, the modulation and coding provides quasi-error free reception of data. This provides broadcasters with a great deal of flexibility on how to transmit the necessary data, and minimal repetition is likely to be required, allowing a wide range of features to be used. In HF channels, however, reception errors are to be expected and therefore transmitting a large number of different data entity groups is likely to be troublesome. In this case, restricting the overall amount of data to the minimum required (for example labelling and alternate frequencies only) is recommended in order to ensure that the repetition strategy will work.

Receivers need to aggregate together all the information according to the normal SDC rules.

It is possible to abort the transmission of a sequence of segments in order to transmit more time critical data, for example if an announcement is being made. This is achieved by inverting the version flag and beginning the transmission of the new sequence of segments.

6 Baseband coding

6.1 Structure of baseband coding

The AM signalling system uses the baseband coding structure of AMDS [2]. The largest element within the structure is called a group. One group consists of two blocks; respectively block 1 and block 2. Each block contains a payload and a check word. In order to distinguish block 1 from block 2 and so connect the correct two blocks that form a group, each block has an offset word added. This also improves block synchronization.

Each AM signalling group is 94 bits long. Each block is 47 bits long. The block contains a 36 bit payload, $m(x)$, and an 11 bit check word, $c(x)$. The coding of the payload for block 1 and block 2 is given in clause 5.

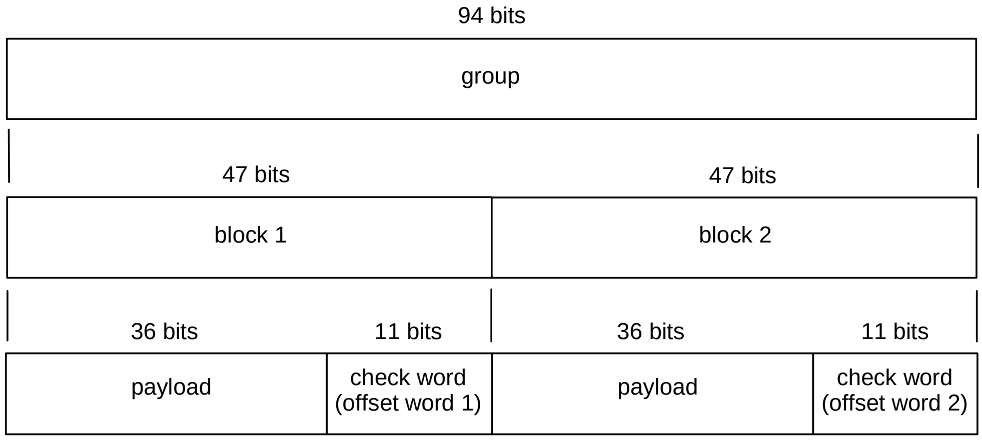

Figure 2: Baseband coding structure

6.2 Features of data transmission

The data is transmitted most significant bit first. For each group, the first bit to be transmitted is the MSb of the payload of block 1; the last bit to be transmitted is the LSb of the check word of block 2.

The transmission of data is fully synchronized (i.e. there are no gaps between groups and blocks).

6.3 Error protection

In order to enable the receiver/decoder to detect and correct transmission errors, each block is assigned an 11 bit check word, $c(x)$. This check word is calculated as follows (all arithmetic modulo 2):

1) multiply the 36 bit payload, $m(x)$, by x^{11};

2) take the remainder of the division (modulo 2) of the above by the generator polynomial $g(x)$;

3) add an 11 bit binary sequence, the offset word $d(x)$, to the above;

such that:

$$c(x) = d(x) + \left(x^{11} \times m(x)\right) \bmod g(x) \qquad (1)$$

where $g(x)$ is given by:

$$g(x) = x^{11} + x^{8} + x^{6} + 1 \qquad (2)$$

Different offset words, $d(x)$, are used for the different blocks 1 and 2 in a group. The 11-bit binary sequence for the offset words for block 1 and block 2 are shown in table 3.

Table 3: Offset words

	Offset word *d(x)*										
	d10	d9	d8	d7	d6	d5	d4	d3	d2	d1	d0
Block 1	0	1	0	1	1	0	1	0	1	0	1
Block 2	1	0	1	1	0	1	0	1	0	1	1

The error code can detect:

- all single and double errors in a block;
- any single burst spanning 10 bits or less;
- about 99,90 % of bursts spanning 11 bits;
- about 99,95 % of all longer bursts.

The error code is capable of error correction as well as detection. However, the correcting power is limited since, in the presence of many errors, there will be uncorrectable error patterns that are deemed correctable and therefore pass undetected. Simulations have shown that no more than 1 bit per block should be corrected. In LF and daytime MF channels it is likely that reception will be largely error free.

6.4 Block and group synchronization

The beginning and end of a block as well as the beginning and end of a group may be detected in the receiver/decoder by using the two offset words for block 1 and block 2. 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.

NOTE: Useful information is provided in the RDS specification [3] concerning synchronization, although it should be observed that the examples relate to the RDS group of four blocks each with 16-bit of payloads and 10-bit check words.

7 Modulation

The data for the AM signalling system is conveyed by using phase modulation of the AM carrier by a shaped, bi-phase coded waveform.

The phase modulation is symmetrical about the nominal rest position of the carrier and the peak phase deviation is ±20º either side of this nominal rest position. The data bit period, $t_d = 1/46,875$ s. At a sampling rate of 12 kHz, this gives a data bit period of 256 samples.

A binary data bit "1" is signalled by a phase advance followed by a phase retardation. A binary data bit "0" is signalled by a phase retardation followed by a phase advance.

For each data bit to be transmitted, a pair of impulses is generated with each member of the pair spaced $t_d/2$ apart in time. For a binary data bit "1", a positive going impulse followed by a negative going impulse is generated. For a binary data bit "0", a negative going impulse followed by a positive going impulse is generated.

These impulse-pairs are then shaped by a filter, $H_T(f)$, a root-raised cosine where the frequency response is:

$$H_T(f) = \begin{cases} \cos(\pi f t_d / 4) & : 0 < f \le 2/t_d \\ 0 & : f > 2/t_d \end{cases} \qquad (3)$$

This results in the phase modulation waveform $\theta(t)$ which must be scaled to ensure a peak value of ±20º; a positive value indicates a phase advance. A carrier of the appropriate frequency ω_c and amplitude A_0 is then modulated by this phase information such that the AMSS signal $s(t)$ is given by:

$$s(t) = \mathrm{Re}\left\{p(t) A_0 e^{j\omega_c t}\right\} \qquad (4)$$

where $p(t)$ is given by:

$$p(t) = e^{j\theta(t) 2\pi / 360} \qquad \textit{(with } \theta \textit{ expressed in degrees)}$$

This AMSS signal $s(t)$ is then fed to the carrier input of an AM transmitter where the amplitude modulation and any dynamic carrier control is performed in the conventional way. The generation process is illustrated in figure 3.

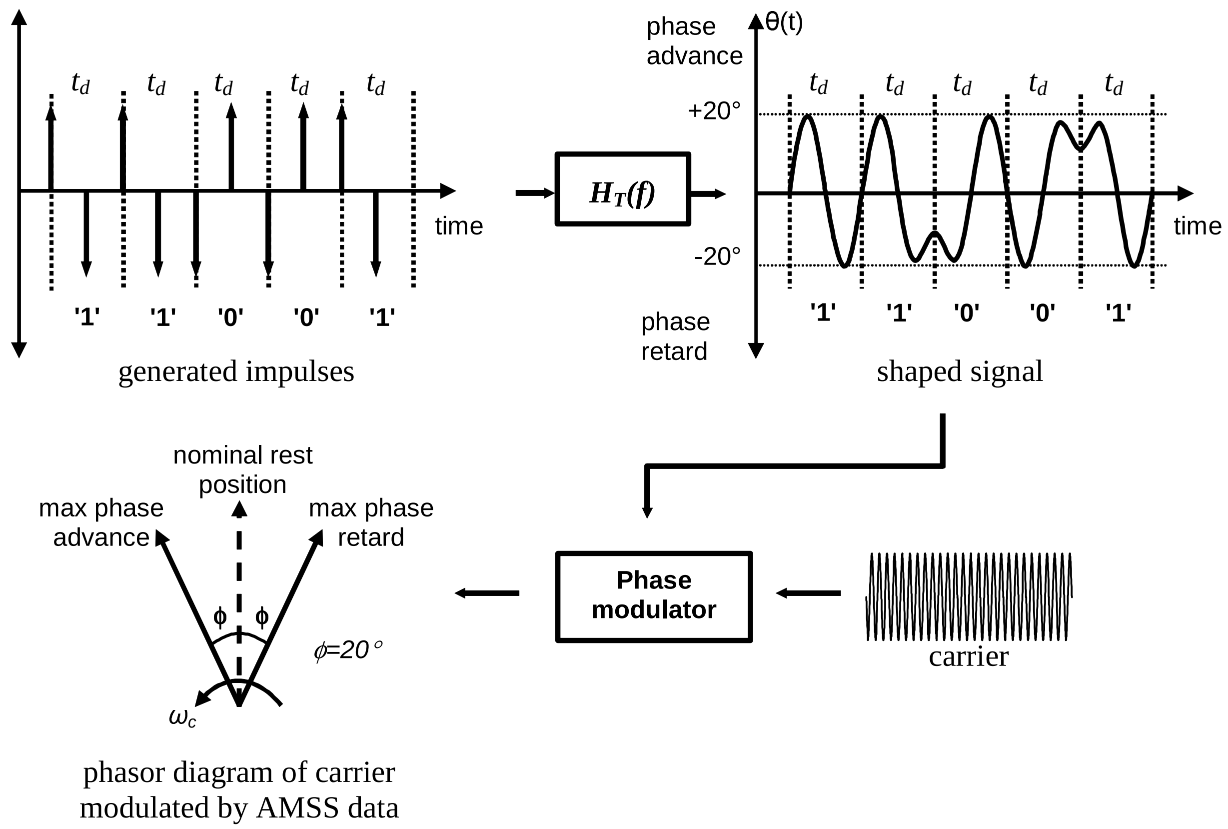

Figure 3: AMSS Generation

History

Document history		
V1.1.1	March 2005	Publication
V1.2.1	March 2006	Publication