

RECOMMENDATION ITU-R BS.706-2

DATA SYSTEM IN MONOPHONIC AM SOUND BROADCASTING (AMDS)

(Question ITU-R 60/10)

(1990-1992-1998)

The ITU Radiocommunication Assembly,

considering

- a) the growing interest for a data transmission system for AM broadcasting and its applications;
- b) that it is desirable to have one system applicable to all AM broadcasting bands and that the future introduction of SSB in HF and of synchronous detection should be taken into account;
- c) that existing systems cannot be implemented on single-sideband (SSB) transmission in band 7 (HF);
- d) that certain applications of an AM data transmission system could correspond to similar features in the FM radio data system (RDS), as defined in Recommendation ITU-R BS.643, taking account of the lower bit rate available;
- e) that the design of such a system should take into account the mass production of receivers;
- f) that data signals can be added to existing AM broadcast transmissions in such a way that they are inaudible, thus achieving good compatibility with reception of the normal monophonic sound programme signals,

recommends

1 that a system for data transmission in AM broadcasting (AMDS) should fulfil the requirements listed in Annex 1;

2 that since a system is not available for SSB in band 7 (HF) and for AM-Stereo in band 6 (MF) a system for data transmission in AM-DSB broadcasting bands 5 (LF), 6 (MF) and 7 (HF) shall fulfil the requirements listed in Annex 1 and shall comply with the minimum specification listed in Annex 2.

NOTE 1 – Information regarding operational or projected systems is given in Annex 3.

ANNEX 1

Requirements for an AM radio-data transmission system**1 Compatibility aspects****1.1 Compatibility with the main programme**

The supplementary data system must be compatible with the main audio programme under all operational conditions including:

- transmitters operated with energy-saving carrier-control techniques;
- synchronized networks of transmitters;

- SSB transmissions (if the introduction of an AM data system in HF broadcasting is feasible);
- transmitters which are used as a high stability frequency reference;
- mobile reception and, where necessary, reception with a stereophonic AM receiver in band 6 (MF).

1.2 Compatibility with other programmes in co- or adjacent channels

The protection ratios used in planning should not be affected, i.e. no additional interference should be caused to the audio programme signal by the data signals.

2 Reliability of data reception

The area in which the data signal can be reliably received, should be at least as large as that where the main programme service for ground- and sky-wave propagation conditions is provided.

3 Applications

Because of the low data-rate which is expected to be available in an AM radio-data system, it may not be feasible to support simultaneously more than a few of the applications listed below.

It is expected that a large part of the data-transmission capacity will usually be used for features related to automatic or assisted tuning functions. These features are therefore labelled "primary". Other applications are labelled "secondary" and may be introduced to meet the needs of individual broadcasters. Note that although similar terms are used, these features may not correspond exactly with those used in RDS (see Recommendation ITU-R BS.643).

Primary

- Programme Identification (PI) code including:
 - unique country code for each ITU country;
 - unique language code.
- List of Alternative Frequencies (AFs).
- Programme Service (PS) name: this comprises at least four alpha-numeric characters and is intended for display.
- Scheduling information (SI).
- Traffic Programme (TP) identification and Traffic Announcement (TA) identification.

Secondary (examples)

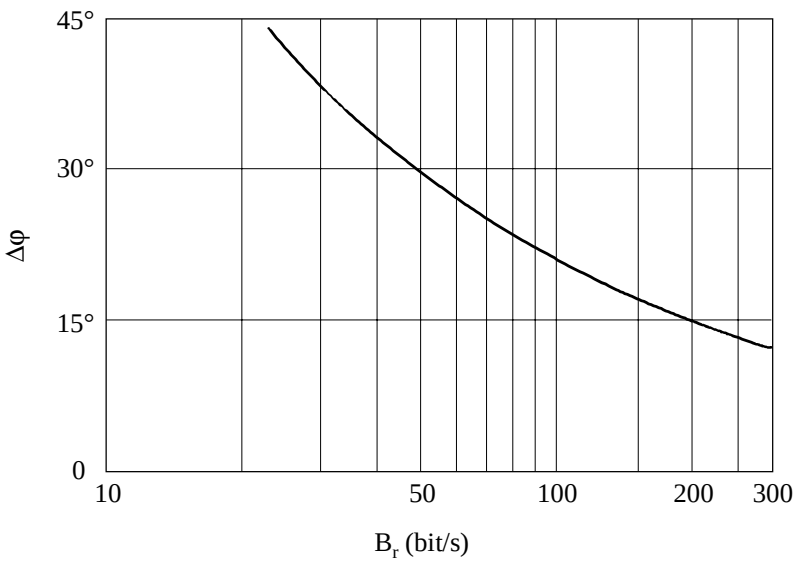
- Differential GPS data (dGPS)
- Clock-Time (CT) and date (UTC and MJD)
- Programme Item Number (PIN)
- Decoder Identification code (DI) (e.g. stereo)
- Programme Type code (PTY)
- Transparent Data Channel (TDC)
- In-House (IH) applications
- Traffic Message Channel (TMC)
- Radio Paging (RP).

ANNEX 2

Specification of a data system for use in monophonic AM sound-broadcasting

Frequency bands:	LF, MF and HF
Method of modulation:	phase modulation of the main carrier
Maximum phase deviation:	depending on bit rate according to Fig. 1
Data format for bit rates below 100 bit/s:	depending on application
Data format for bit rates ≥ 100 bit/s:	according to Annex 4

FIGURE 1
Dependence of the permitted phase deviation value Δφ
on the transmission bit rate (B_r)



Δφ: maximum peak phase deviation

$$\Delta\varphi = \frac{210}{\sqrt{B_r(\text{bit/s})}} \quad (\text{degrees})$$

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Information on operational and projected AM data systems (AMDS)

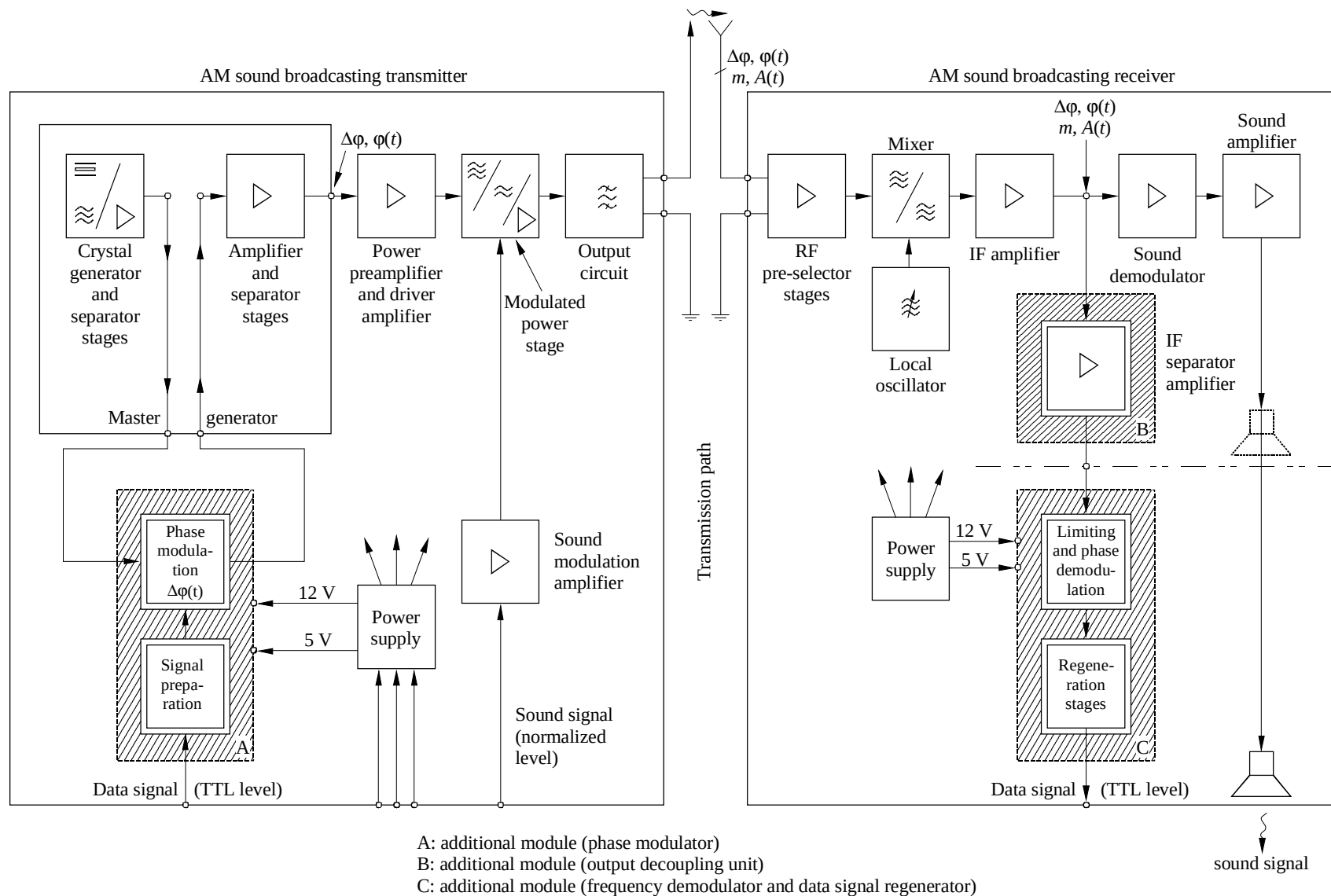
Table 1 gives information on AMDS systems as applied in different countries.

TABLE 1

Application of AMDS systems

Characteristics	United Kingdom	France	Germany
– Operating frequency band	LF	LF	LF, MF, HF
– Possible frequency bands	LF, MF	LF, MF, HF	LF, MF, HF
– Phase deviation	$\pm 22.5^\circ$	$\pm 28.5^\circ$	$\pm 15^\circ$
– Bit rate	25 bit/s	40 bit/s	200 bit/s
– Data coding	Bi-phase	NRZ	NRZ
– Data structure	Blocks of 50 bits with 32 useful	Blocks of 50 bits with 32 useful	Blocks of 47 bits with 36 useful
– Achieved bit error ratio (normal conditions)			$< 10^{-3}$ for LF and MF (50% time)
– Application	Coded weather information Electricity supply switching	Time information	Automatic or assisted tuning Traffic information
In operation since	1985	1986	Field tests since 1988
Reference		French national standard NFC 90-002	

FIGURE 2
 Basic circuit diagram of a monophonic AM sound broadcasting system (AMDS)
 for supplementary data transmission



ANNEX 4*

- 1 Baseband coding
 - 1.1 Structure of baseband coding
 - 1.2 Features of data transmission
 - 1.3 Error protection
 - 1.4 Block and Group synchronization
- 2 Data format
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 - 4.7.1 Coding of START and END
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 - 4.8.1 Information addressed by the usage code UCI
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 - 4.9 Group type 8/Additional tuning information ATI
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* Editor's Note - The text of Annex 4 is new.

1 Baseband coding

1.1 Structure of baseband coding

Figure 3 shows the structure of the baseband coding. The largest element within the structure is called a **Group**. One Group consists of 2 **Blocks** with 47 bits each. Each Block contains one **information word** (36 bits) and one **check word** (11 bits). To distinguish the Blocks of a Group and to improve the Block synchronization, each Block is superimposed by an **offset word** (11 bits, modulo-2 addition).

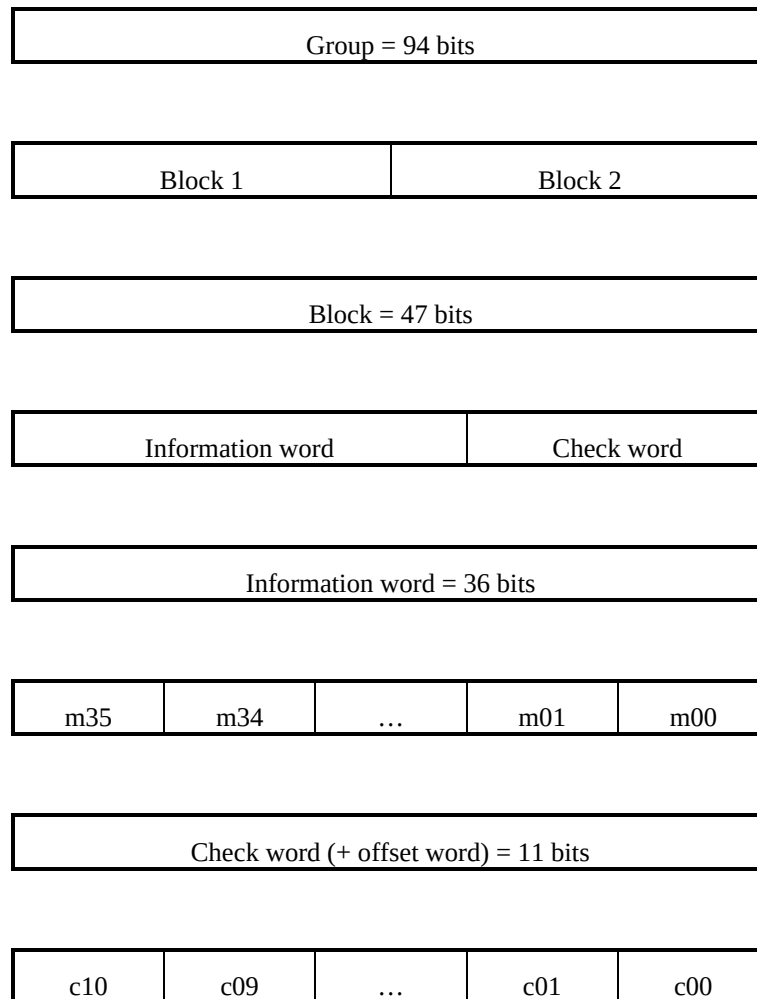


FIGURE 3

Baseband coding structure

1.2 Features of data transmission

For all information words, check words, binary numbers or addresses, the most significant bit will be transmitted first (Figure 4). The order assigned to the binary number or address bit transmitted last is 2^0 .

The transmission of data is fully synchronized, i.e. there are no gaps between Groups and Blocks.

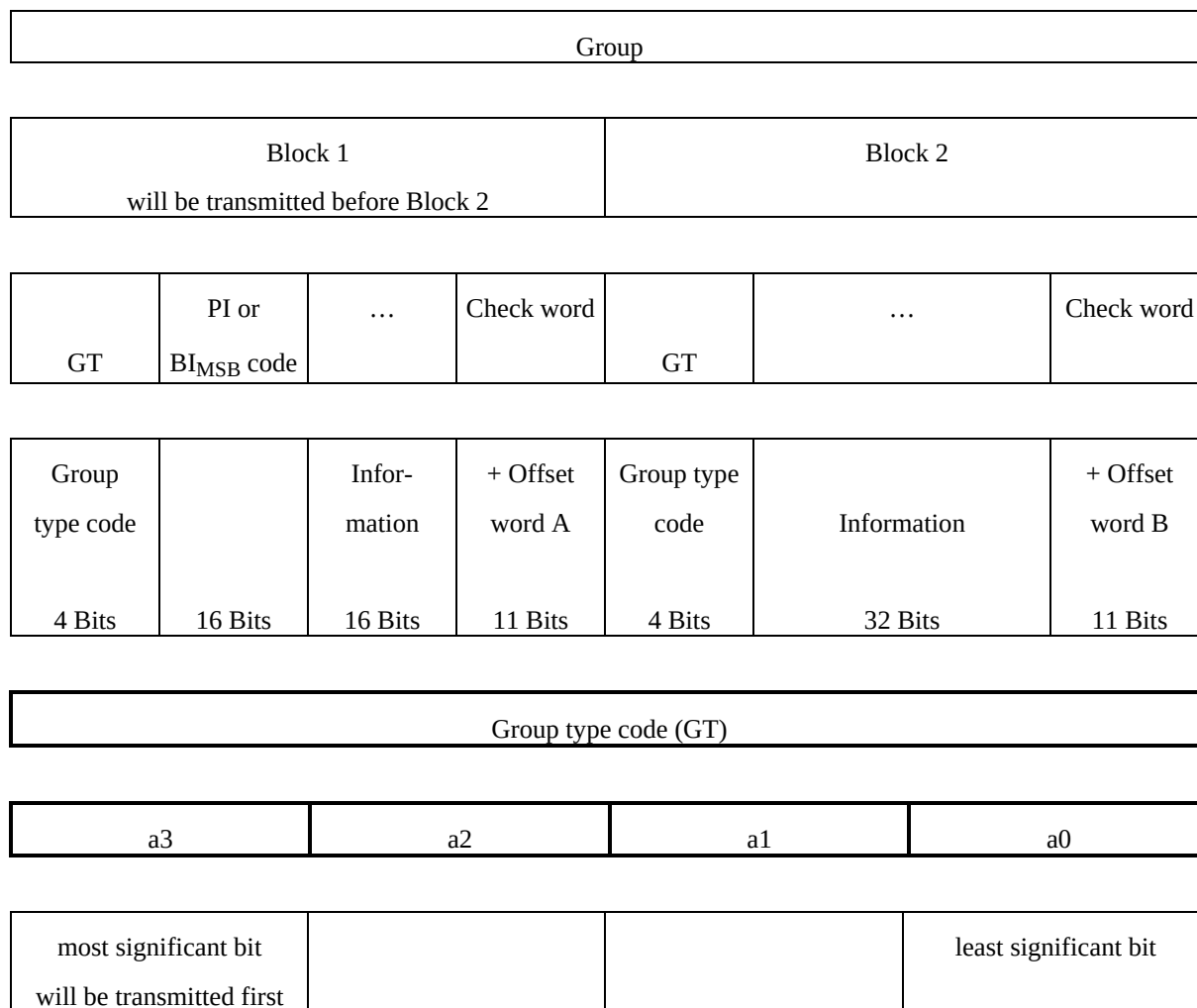


FIGURE 4
Data format and addressing

TABLE 2
Data elements

Data element	Note	Chapter
Check word	Error detection, error correction, Block and Group synchronization	2.1 - 2.4
PI code	Programme identification code	3.2.1
BI code	Broadcast identification code	3.2.2
GT	Group type	4
Information	is defined by the Group type code	5.1 - 5.11
X	unused capacity	5.1 - 5.11

1.3 Error protection

In order to enable the receiver/decoder to detect and correct transmission errors, each Block is assigned a check word (11 bits). This check word

$c(x)$ ($c_{10}, c_9, \dots, c_0$ shown in Figure 3) is the sum total (modulo 2) of:

- the remainder obtained after multiplication of the 36-bit information word $m(x)$ by x^{11} and a following division (modulo 2) by the generator polynomial $g(x)$, and
- an 11-bit binary sequence $d(x)$, called offset word such that:

$$c(x) = d(x) + \frac{m(x) \cdot x^{11}}{g(x)} \quad \text{mod } g(x) \quad (1)$$

whereby the generator polynomial (degree 11) may be described by the following formula:

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

Different offset words A and B are used for each Block of a Group.

The 11-bit binary sequence for the offset words A and B are shown in the table below:

TABLE 3
Offset words

Offset	Offset word $d(x)$										
	d10	d9	d8	d7	d6	d5	d4	d3	d2	d1	d0
A	0	1	0	1	1	0	1	0	1	0	1
B	1	0	1	1	0	1	0	1	0	1	1

The error protection code offers the following features:

- detects all single and double errors in a Block;
- detects any single burst spanning 10 bits or less;
- detects about 99.90% of bursts spanning 11 bits; and
- about 99.95% of all longer bursts.

The code is an optimal burst error correcting code and is capable of correcting any single burst of span 5 bits or less. Depending on the number of errors within a Block or within the content of a Block the receiver/decoder may utilize either the error detection mode or the error correction mode or both of them.

The probability of unrecognized errors depends on the number of errors which are corrected. Field trials have shown that no more than 2 errors in a Block should be corrected.

1.4 Block and Group synchronization

The beginning and end of a data Block as well as the beginning and end of a Group may be detected in the receiver/decoder by using the two offset words A and B. 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. By means of this method the Block synchronization becomes reliable.

2 Data format

2.1 Definitions relating to the data transmission

There is no specific repetition cycle fixed for the various types of Groups (see § 4), i.e. a large degree of flexibility is provided. This allows the user to create combinations of different types of information, which comply with his requirements.

The selected data format comprises 5 Group types which are still unused and therefore provides a sufficient degree of adaptability for future applications.

In order to ensure efficient utilization of the AM data channel, the number of different types of information is minimized within a given Group. Thereby the user will not be forced to waste data capacity by the transmission of unused information.

The first 4 bits of each Block are assigned to the Group type code (Figure 5) specifying the application of the Group. By this process each Block of a Group can be decoded within the receiver/decoder without reference to the other Block. Thus the access time for data which are transmitted in several Blocks is reduced during interference.

2.2 Programme identification

The programme identification is a code which enables the receiver to distinguish between country of origin, programme area, language and the identification of the programme itself.

The code is not intended for direct display. It is assigned to each individual broadcast programme to identify transmitters radiating the same sound programme. By this code the mobile receiver/decoder is enabled to search automatically for an alternative frequency in case of bad reception of the just received frequency. In cases of stationary reception and especially in the HF bands the listener may start search tuning for transmissions originated in a specific country with a desired language.

Except for Group type 5 (Transparent Data Channel) the programme identification is always included in the first Block of each Group (see Figure 5). Depending on the service two different codes for the programme identification are available. These are the BI code and the PI code.

2.2.1 PI code

The usage of the PI code is equivalent to RDS. For reasons of compatibility with RDS, transmissions that are implemented on LF and/or MF and also on VHF/FM Band II, have to be identified with the PI code. This is necessary for automatic search tuning on all bands and moreover to support cross-border functions especially for the TMC service (Traffic Message Channel).

TABLE 4

PI structure

Bits	Identification
1 to 4	Country identification
5 to 8	Programme type in terms of area coverage
9 to 16	Programme reference number

Extended country codes (ECC) may optionally be transmitted to render the country identification in bits 1 to 4 of the PI code unique. The extended country code consists of eight bits and is coded according to RDS-Standards.

2.2.2 BI code

The BI code (Broadcast identification) should be used to facilitate maximum flexibility with respect to tuning and searching for a particular HF transmission. An eight-bit extension (bits 17 to 24) allows identification of up to 32 broadcasters (organization number has to be agreed nationally) and up to 8 different simultaneous programmes from a single broadcaster (programme marker).

TABLE 5

BI structure

Bits	Identification
	BI_{MSB}
1 to 8	Country identification (255 countries can be coded) ¹⁾
9 to 16	Language code (255 languages can be coded)
	BI_{LSB}
17 to 21	Organization number (32 organizations within a country)
22 to 24	Programme marker (8 programmes)

¹⁾ These country codes are given in Appendix A.

NOTES: Use of PI vs. BI code:

- For reasons of compatibility with RDS, those programmes that are implemented on LF and/or MF and VHF/FM Band II, have to be identified with **PI-code**. The use of the ECC code will be optional.
- All other applications can use **BI code** instead of the **PI code**.
- For HF, the **BI code** should be used to facilitate maximum flexibility with respect to tuning and searching for a particular transmission.
- The usage of BI or PI code is signalled by the codeflag CF.
- A short designation of the respective country could be derived from the Country identification or ECC to be shown on the receiver display. 2-Letter ISO 3166 codes are recommended.

3 Group types

The application of a Group is determined by the Group type code, i.e. the first 4 bits in each Block (Figure 5). The assigned Group types for the different applications are listed in Table 6.

TABLE 6

Group types

Group type					Application	Type of information
Dec	Binary Code					
	A3	A2	A1	A0		1)
0	0	0	0	0	Basic tuning and switching information BTI	interactive
1	0	0	0	1	Radiotext RT	interactive
2	0	0	1	0	Alternative frequencies AF	interactive
3	0	0	1	1	Traffic message channel TMC	interactive
4	0	1	0	0	In-House applications IH	various
5	0	1	0	1	Transparent data channel TDC	various
6	0	1	1	0	Scheduling information SI	off-line
7	0	1	1	1	Supplementary scheduling information SIS	off-line
8	1	0	0	0	Additional tuning information ATI	interactive
9	1	0	0	1	Differential Global Positioning System data dGPS	interactive
10	1	0	1	0	Time information UTC	interactive
11	1	0	1	1	Undefined	
12	1	1	0	0	Undefined	
13	1	1	0	1	Undefined	
14	1	1	1	0	Undefined	
15	1	1	1	1	Undefined	

¹⁾ The reception of a Group can have different effects on the actions subsequently taken:

interactive = The information is treated directly by the receiving system and results in either tuning or change of settings, display or storage.

Off-line = The information is stored for further reference and will be basically used to update a database in the receiving system.

Various = The actual effect on or at the receiving system depends on the application and the type of data transmitted.

3.1 Usage of Groups

TABLE 7
Usage of Groups for different applications

Application	Primary Groups	Secondary Groups
LF-MF station identification	0,2	1,4,8,10
HF station identification	8,2	1,4,10
LF-MF TMC	0,3,2	1,4,8,10
LF-MF-dGPS	0,9,2,5	1,4,8,10
LF-MF-scheduling	0,2,6,7	1,4,8,10
HF-scheduling	8,2,6,7	1,4,10

3.2 Group sequences

Unlike RDS applications, a fixed Group sequence cannot be given for AMDS. The sequence depends on the amount of data that is to be transmitted and the envisaged reaction time at the receivers.

If for example, it is necessary to have a PS-name to appear on the receivers display within 3 seconds, Group 0 is transmitted at least every 6th Group (error-free conditions). In a heavily distorted environment as in HF, it is advisable to send every 3rd Group in the sequence a Group 8.

Basis for the calculation of Group sequences is the Group duration of $T_G = 0.47$ second (s) under error-free conditions. The Group sequence can then be derived from the formula:

$$N_{oc} = \frac{T_R}{T_G} \quad (3)$$

where:

N_{OC} is the repetition rate of the particular Group within a sequence

T_R is the wanted reaction time at the receiving terminal in (s)

T_G is the Group duration in (s)

In HF-applications it has been found that a dynamic Group sequence is appropriate, for example:

Transmission is due to start at 1200 UTC.

TABLE 8
Dynamic Group sequences

Time (UTC)	Group sequence	Task
1159-1200	8,2,8,2	Station name and alternative frequencies
1200-1201	8,2,1,8,2,1	Station name, alternative frequencies and radiotext
1201-1204	8,2,6,7,8,6,7	Station name and scheduling information
1204-1205	8,2,8,2	Station name and alternative frequencies