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Method for transmitting additional information in an AM radio signal

DESCRIPTION

5 The invention relates to an additional information signal according to the preamble of Patent Claim 1. Such a signal is known from the research paper BBC RD 1982/2 from the British Broadcasting Corporation "L.F. Radio-Data: Specification of the BBC experimental transmissions 1982" dated August 1982.

10 The aforesaid research paper discloses how digital, coded additional information is transmitted in an AM (amplitude modulation) radio signal by means of phase modulation and demodulation of the AM radio signal carrier. In order to prevent the station signal of the
15 phase-modulated AM carrier from being disrupted, the British Broadcasting Corporation selected a value of $\pm 22.5^\circ$ as the maximum acceptable phase-angle deviation, which corresponded to a transmission capacity for the additional information of 25 bit/s. This extremely small
20 channel capacity requires error protection which is matched as well as possible in terms of low redundancy to the properties of the AM radio transmission channel. For this purpose, the data stream is divided up into blocks with a length of 50 bits each, each block comprising a
25 synchronous bit, an information word of 36 bits and a check word of 13 bits. For the block coding, use is made of an optimum error-correcting code with which an error burst up to a length of 6 bits can be corrected. The selected code is cyclical and is shortened to the block
30 length of 50 bits. In order to be able to detect the start of blocks reliably, the synchronous bit is placed in front of the block at the transmitter end, as a result of which the cyclical character of the block code is destroyed. In order to identify the contents of the

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32-bit-long information word, a 4-bit-wide block use code is transmitted directly after the synchronous bit at the start of the information word. Within the information word, a specific information coding is provided, in conjunction with the block use code 0000, exclusively for the information relating to the time and calendar date.

In contrast to the above, the object of the invention consists in reducing the redundancy in the case of an additional information signal of the type mentioned at the beginning and in facilitating the assignment, and thus detection, of different items of information.

This object is achieved according to the invention by means of the characterizing features of Patent Claims 1 and 2.

Advantageous refinements and developments of the additional information signal according to the invention emerge from the Subclaims 3 to 10. A method for transmitting an additional information signal according to the invention is disclosed in the independent Claim 11, while a method for receiving an additional information signal according to the invention is disclosed in the independent Claim 14.

Advantageous refinements and developments of the methods according to Claims 11 and 14 emerge from the Subclaims 12, 13 and 15, 16.

The invention is explained in greater detail below with reference to the exemplary embodiments illustrated in the drawings. In the description of the drawings, the number of information blocks is, as disclosed in Claim 2, limited to the number two.



1. Baseband coding

1.1 Structure of the baseband coding

Figure 1 shows the structure of the baseband coding. The largest element within the structure is referred to as group. A group comprises 2 blocks with 47 bits each. Each block contains an information word (36 bits) and a check word (11 bits). In order to distinguish between the blocks of one group and in order to permit reliable block synchronization, an offset word (11 bits) is superimposed on each check word (modulo 2 addition).

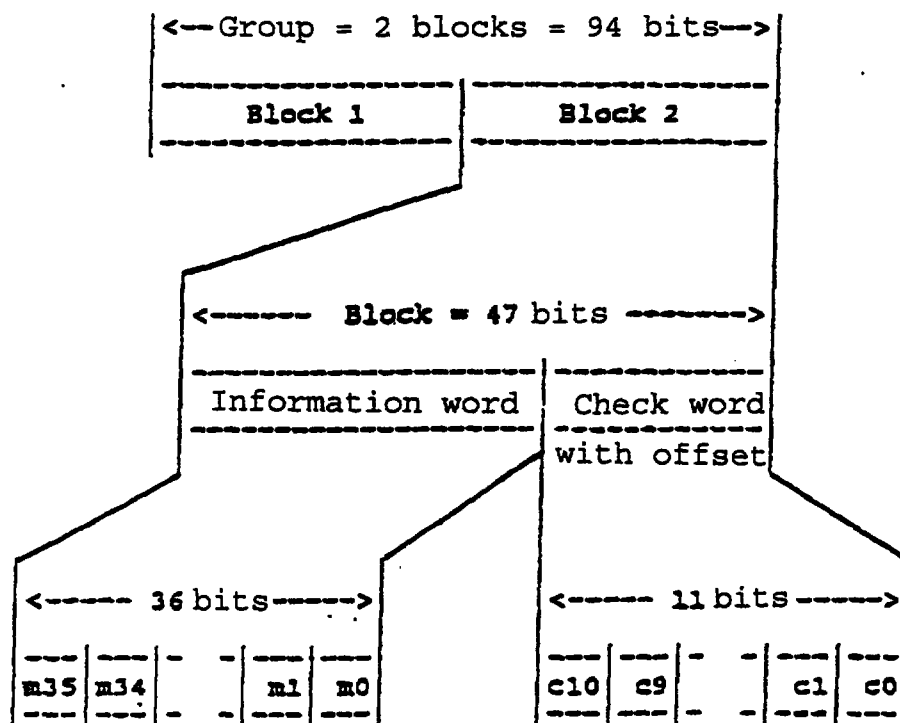


Figure 1 Structure of the baseband coding

1.2 Features of the data transmission

15 In the case of all information words, check words, binary numbers or addresses, the highest-order bit is transmitted first (Figure 2). The last bit of a binary number or address to be transmitted has the value 2^0 .

The data transmission is completely synchronous,

i.e. there are no gaps between groups or blocks.

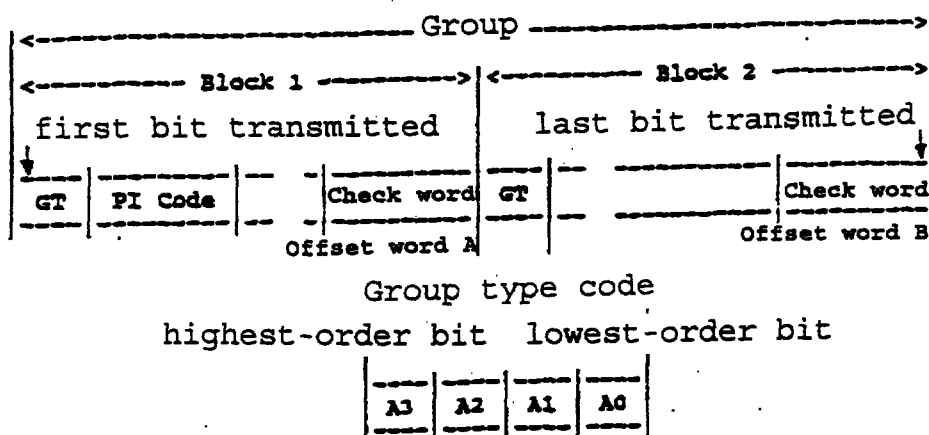


Figure 2 Data format and addressing

Explanations

	GT	Group type code	(4 bits) cf. 2.2
5	PI code	Station series identification	(16 bits) cf. 2.1
	Check word	for error protection, block synchronization and group synchronization	(11 bits) cf. 1.3
10	X	unused capacity	cf. 2.2.1-2.2.5
	Block 1 of each individual group is transmitted first.		

1.3 Error protection

- Each block has a check word (11 bits) for detecting and correcting transmission errors in the receiver/decoder. This check word ($c_{10}, c_9, \dots, c_0$ in Figure 1) is the sum (modulo 2) of:
- the remainder after multiplication of the 36-bit information word $m(x)$ by X^{11} and subsequent division (modulo 2) by the generator polynomial $g(x)$
 - an 11-bit binary sequence $d(x)$, referred to as offset word



$$\text{or check word } c(x) = d(x) + \frac{m(x) x^{-11}}{g(x)} \bigg| \text{mod } g(x)$$

the generator polynomial (degree 11) being described by the following equation:

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

- 5 and different offset words being used for each block within a group.

The 11-bit binary sequence for the offset words A and B is defined as follows:

	Offset	Offset word d(x)										
10		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 has the following properties:

- 15 - it detects all the individual errors and double errors in a block
- it detects each individual error burst up to 11 bits
- it detects approximately 99.90% of the error bursts with 11 bits and approximately 99.95% of all the
- 20 longer bursts

The code is also an optimum error-correcting code for error bursts up to a length of 5 bits. Depending on the number of errors of a block or on the block contents, either the error detection or the error correction, or

25 else both, can be used at the reception end.

1.4 Block synchronization and group synchronization

By using the two offset words A and B, both the start and end of a block and the start and end of a group



can be detected in the receiver. The offset words destroy the cyclical nature of the original code, so that cyclical displacements of code words of the modified code do not permit any other code words to be produced and thus make this type of block synchronization reliable.

2. Data format

2.1 Definitions for data transmission

There is no fixed repetition rhythm for the different group types (cf. 2.2), i.e. there is enough flexibility to connect the different types of information chronologically in such a way that they fulfil the requirements of the user.

The selected data format also has 10 free group types and is thus sufficiently adaptable to allow for future uses also.

In order to ensure effective utilization of the channel, the smallest possible number of different types of information is mixed in one group. As a result, the user is not forced to waste channel capacity as a result of transmitting unused information.

The first 4 bits in each block are assigned to the group type code (cf. 2.2) which specifies the use of the group. As a result, it is possible to decode each block of a group in the receiver/decoder without reference to another block. Thus, in the event of transmission faults, the access time to information which is divided up between a plurality of blocks is reduced.

In each case the first block of a group contains the station series identification PI.

30 PI code

The PI code (station series identification) comprises a code (16 bits) which permits the receiver to distinguish between nationality, station area/language area and station code. The PI code is not provided for direct display, it is individually assigned to each radio station and serves to detect transmitters which broadcast

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the same station. As a result, the receiver/decoder is enabled to search for an alternative frequency automatically in the event that the transmitter which has been set during mobile reception becomes too bad.

- 5 The coding below makes it possible to distinguish between 256 countries, 16 station areas and 16 stations.
- Bit 1 - 8 Nationality identification
- Bit 9 - 12 Station area identification/language areas
- Bit 13 - 16 Station code

- 10 The abbreviation for the respective country can be derived from the nationality identification of the PI code and can be presented on the display of the receiver.

2.2 Group types

- 15 The group type code - the first 4 bits of a block (Figure 2) - determines the use of the group. The previously defined group types can be found in the table below.

	Group type code					Use
	Decimal value	Binary code				
		A3	A2	A1	A0	
20	0	0	0	0	0	PS Name of the station series
	1	0	0	0	1	RT Radio text
	2	0	0	1	0	AF Alternative frequencies
	3	0	0	1	1	TMC Traffic message channel
25	4	0	1	0	0	IH Internal radio use
	.	.	.	.	.	Not defined
	15	1	1	1	1	

Table 1 Group types



2.2.1 Group type 0

Name of the station series

PS

Switching information

TMC, TP, TA

Figure 3 shows the data format of group type 0.

Block 1

4	16	1	1	7	7
GT	PI Code	T	T	PS	PS
		M	P	Drawing 1	Drawing 2
		C			

Block 2

4	1	3	7	7	7	7
GT	T	X	PS	PS	PS	PS
	A		Drawing 3	Drawing 4	Drawing 5	Drawing 6

5 Figure 3 - Data format of group type 0

PS

The name of the station series is transmitted as a 7-bit character (Table 2, columns 2-7) in accordance with the ISO 646 code tables for display in the receiver.

- 10 6 characters, including idle signals, are provided for the name. The position of the individual characters in the name corresponds to the appendant number. The transmission of the name begins with the character 1. The highest-order bit of each character is transmitted first.
- 15 Receivers with a display of more than 6 characters could additionally display the respective nationality abbreviations (cf. 2.1 PI code).

TMC

- 20 TMC (traffic message channel) is a switching signal which identifies transmitters which transmit intermittently coded traffic messages. The identification



can be evaluated for an automatic search run for TMC transmitters.

TP

5 TP (traffic radio identification) is a switching signal which identifies transmitters which transmit intermittently announced traffic messages. A lamp or a corresponding device can be used to indicate on the receiver that the station being received is transmitting traffic messages at specific times. The identification
10 can be evaluated for an automatic search run for traffic radio transmitters.

TA

TA (traffic announcement identification) is a switching signal for identifying whether a traffic
15 announcement has been transmitted. The signal can be used in the receiver in the following way:

- automatically switching on the traffic announcement if the receiver is in the stand-by mode and is switched to the mute setting;
- 20 - automatically switching over from cassette playback to the traffic announcement;

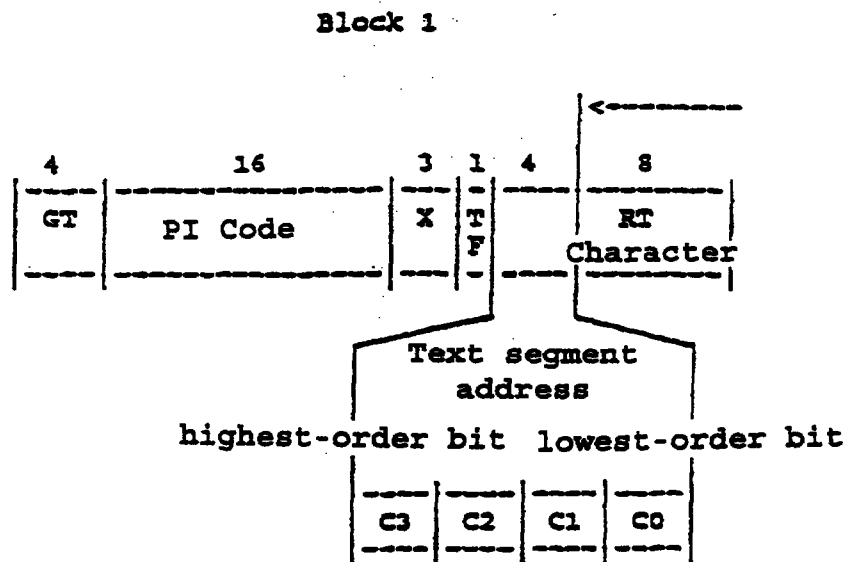
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2.2.2 Group type 1 Radio text RT

Figure 4 shows the data format of group type 1.



Block 2

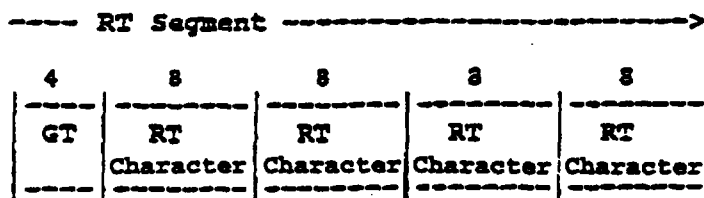


Figure 4 - Data format of group type 1

The radio text is transmitted with 8-bit characters in accordance with the ISO 646 code tables (cf. Table 2). The transmission starts with the highest-order bit of a character.

The text segment address in block 1 serves to arrange the text segment, comprising the characters from blocks 1 and 2, in a display or in a memory. By means of the area of the segment address (0-15) and the characters (5) contained in a group, radio texts up to a length of 80 characters can be transmitted.

If a display with less than 80 characters is used



for RT, a memory should be provided in the receiver/decoder, so that parts of the message can be displayed successively.

5 A change of the text flag (TF) in block 1 identifies the transmission of a new radio text. In the receiver/decoder, the text flag is used to clear the display or the memory.

10 RT is principally intended for home receivers with a suitable display and for car receivers, for example for controlling a voice generator.

2.2.3 Group type 2 Alternative frequencies AF

Figure 5 shows the data form of group type 2.

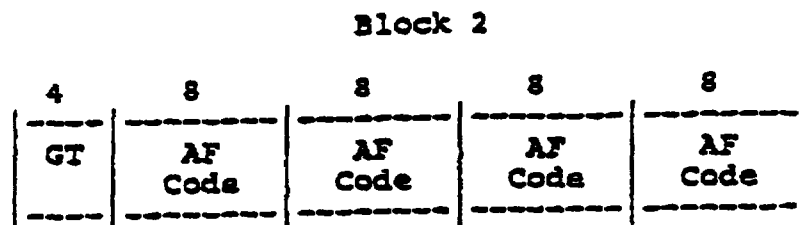
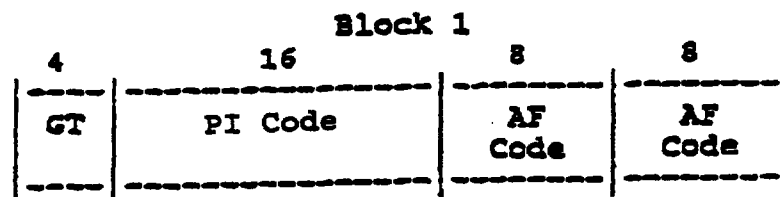


Figure 5 - data format of group type 2

2.2.4 Codes for alternative frequencies

15 Long wave and medium wave

Long wave and medium wave frequencies are represented with 9 kHz spacing by means of an 8-bit code.



	Number	Binary code	Carrier frequency
	1	0000 0001	153 kHz
	15	0000 1111	279 kHz
	16	0001 0000	531 kHz
5	135	1000 0111	1602 kHz

Shortwave

The short-wave frequencies are represented with 5 kHz spacing by means of two 8-bit codes. They are characterized by the fact that the first 8-bit code lies in the range of 140-157. In this case, the first code is to be evaluated in pairs with the following code. Pairs which go beyond a block are unacceptable.

	Number	Binary code	Number	Binary code	Carrier frequency
	140	1000 1100	0	0000 0000	3980 MHz
15	157	1001 1101	190	1011 1110	26100 MHz

VHF

The VHF channels are represented with 100 kHz spacing by means of two 8-bit codes. They are characterized by the fact that the first 8-bit code = 160. In this case, the code identifies, with the following code, a VHF channel. Pairings which go beyond a block are unacceptable.

	Number	Binary code	Number	Binary code	Carrier frequency
	160	1010 0000	0	0000 0000	87.5 MHz
25	160	1010 0000	204	1100 1101	107.9 MHz

Number and filler code

The number code indicates how many frequencies, filler codes excepted, are contained in an AF list. An AF list can contain up to 31 frequencies. The number code is



transmitted at the start of an AF list.

The filler code is used to occupy unused AF codes within the group.

	Number	Binary code	Use
5	136	1000 1000	Filler code
	224	1110 0000	No AF
	241	1110 0001	AF list with 1 frequency
	255	1111 1111	AF list with 31 frequencies

10 The list of alternative frequencies indicates which transmitters in the same reception areas, or in adjacent reception areas, broadcast the same station. Receivers/decoders with a memory for AF lists can thus shorten the switch-over time to another transmitter.

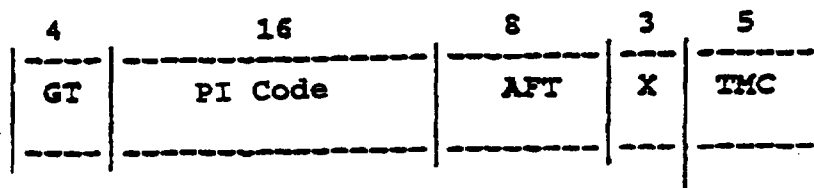
2.2.4 Group type 3

15 Traffic message channel TMC

Alternative frequencies for TMC AFT

Figure 6 shows the data format of group type 3.

Block 1



Block 2

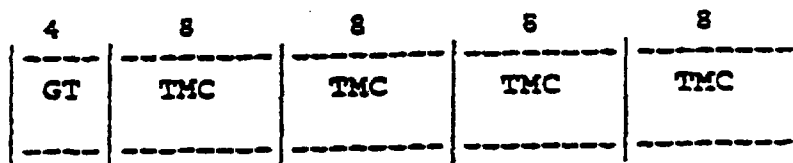


Figure 6 - Data format of group type 3

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The data format complies with the proposals from Blaupunkt and the EBU regarding the information length (37 bits).

5 The alternative frequencies for TMC (AFT) refer only to transmitters with identical, coded traffic messages. These transmitters do not broadcast the same sound program. The AFT is based on the same coding as the alternative frequencies (AF). The use of AFT is limited to LW and MW frequencies.

10 2.2.5 Group type 4 Internal radio information IH
Figure 7 shows the data format of group type 4.

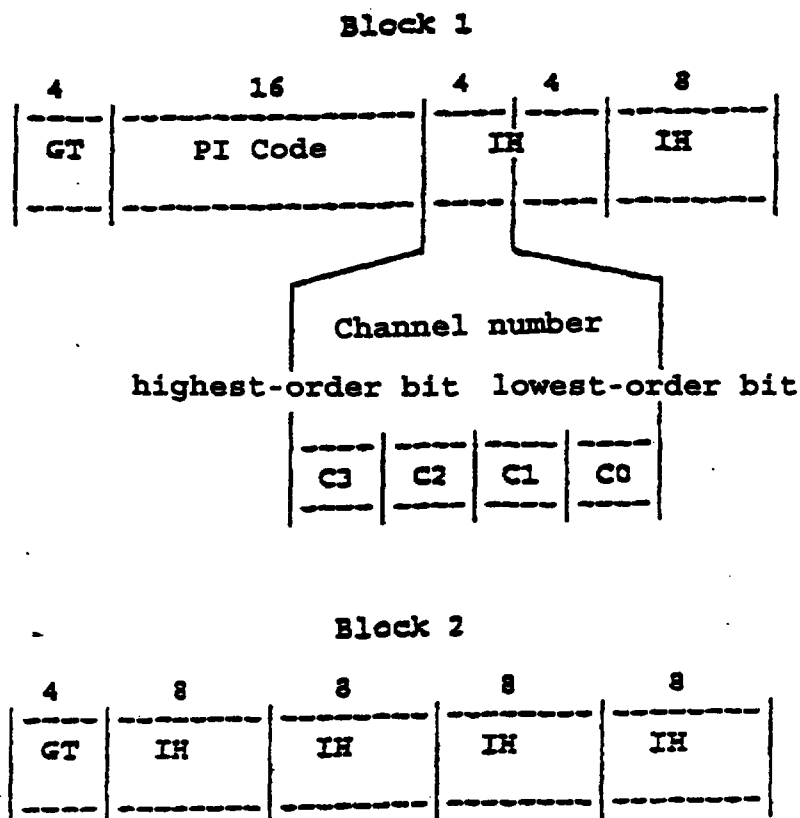


Figure 7 - Data format of group type 4

48 bits are available for IH, 16 bits in block 1 and 32 bits in block 2. The contents of the bits specified with IH may be determined by the radio organization

15



itself. In this context, a data format similar to that of RDS seems expedient. The first 4 IH bits of block 1 are used as channel numbers 0 to 15. The remaining 44 bits are regarded as 11 HEX characters and are available for a bit-transparent data transmission.

Examples of the use of IH:

Station source identification

Remote control of transmitter networks

Paging for company personnel





Patent Claims

1. Digital, coded additional information signal within an AM radio signal, characterized in that the additional information (PI, PS, AF, AFT, TP, TA, TMC, RT) of the additional information signal is divided up into a cyclically repeated number of groups with one information block or to form a plurality of information blocks, in that each information block has an information word and a check word comprising in each case a specific number of data bits, in that, in the case of groups with a plurality of information blocks, the check words of each group have different offset words superimposed on them, and in that the offset words are used at the reception end to synchronize the information blocks.
2. Digital, coded additional information signal within an AM radio signal, characterized in that the additional information (PI, PS, AF, AFT, TP, TA, TMC, RT) of the additional information signal is divided up into a cyclically repeated number of groups to form in each case two information blocks of identical length, in that each information block has an information word and a check word comprising in each case a specific number of data bits, in that the two check words of each group have different offset words superimposed on them, and in that the offset words are used at the reception end to synchronize the information blocks.
3. Additional information signal according to Claim 1 or 2, characterized in that the information words within each group contain, at the start of the word, a group type identification (GT) which identifies the respective group.
4. Additional information signal according to Claim 1, 2 or 3, characterized in that the station identification (PI) which identifies the station series of the respective AM radio signal is contained in each case in the first information block of each group.
5. Additional information signal according to one of Claims 1-4, characterized in that a station service (PS)

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identification which identifies the name of the station series of the respective AM radio signal is always contained in a first group of the cycle.

6. Additional information signal according to
5 Claim 5, characterized in that, in the same group of the cycle in which the PS identification is contained, further identifications are inserted for the identification of the transmitter of the respective AM radio signal as the transmitter for coded traffic messages
10 (TMC identification) and as the traffic radio transmitter (TP identification) and for the switching signal (TA identification) which accompanies an uncoded traffic message.

7. Additional information signal according to one
15 of Claims 1-6, characterized in that radio text information (RT identification) in the form of a sequence of addressed text segments is contained in a second group of the cycle, and in that a binary clear signal (TF) is inserted before each text segment, which clear signal
20 (TF) changes its binary state as soon as a previously transmitted and reproduced text is to be replaced by a new text.

8. Additional information signal according to one
of Claims 1-7, characterized in that information relating
25 to alternative frequencies (AF) of transmitters which broadcast the same station as the currently received AM radio signal transmitter is contained in a third group of the cycle, each item of AF information having an additional identification for the wave range (LW/SW,
30 MW/VHF) of the respective alternative frequency.

9. Additional information signal according to one of
Claims 1-8, characterized in that coded traffic messages
(TMC) and information (AFT) relating to the frequencies
of alternative transmitters which broadcast the same
35 coded traffic messages are contained in a fourth group of the cycle, each item of AFT information having an additional identification for the wave range (LW, MW) of the respective frequency of the alternative transmitter.





10. Additional information signal according to one of Claims 1-9, characterized in that internal radio information (IH) is contained in a fifth group of the cycle.
11. Method for transmitting an additional information
5 signal according to one of Claims 1-10, characterized in that an AM radio signal carrier is modulated in its phase angle with the digital, coded additional information signal.
12. Method according to Claim 11, characterized in
10 that the AF information is transmitted as a continuous list, the number of items of AF information within the list being transmitted at the start of the list.
13. Method according to Claim 11, characterized in
15 that the AFT information is transmitted as a continuous list, the number of items of AFT information within the list being transmitted at the start of the list.
14. Method for receiving an additional information
20 signal according to one of Claims 1-10, the said additional information signal being transmitted in accordance with Claim 11, 12 or 13, characterized in that the received AM radio signal carrier is phase-modulated, the acquired additional information signal is decoded and the decoded additional information is used for tuning, switching and/or playback.
- 25 15. Method according to Claim 14, characterized in that the number of items of AF information which is transmitted at the start of the list of AF information is selected from the received list of AF information and is used to check for the complete reception of the list.
- 30 16. Method according to Claim 14, characterized in that the number of items of AFT information which is transmitted at the start of the list of AFT information is selected from the received list of AFT information and is used to check for the complete reception of the list.
- 35 17. Method according to one of Claims 14-16, characterized in that at least one brief range switch-over is performed if an item of AF information has an additional identification for the wave range (LW, SW, MW, VHF) of





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the respective alternative frequency.

18. Method according to one of Claims 14-17, characterized in that the respective VHF frequency is predominantly set if an AF identification has an additional
- 5 identification for the VHF wave range of the respective alternative frequency.

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