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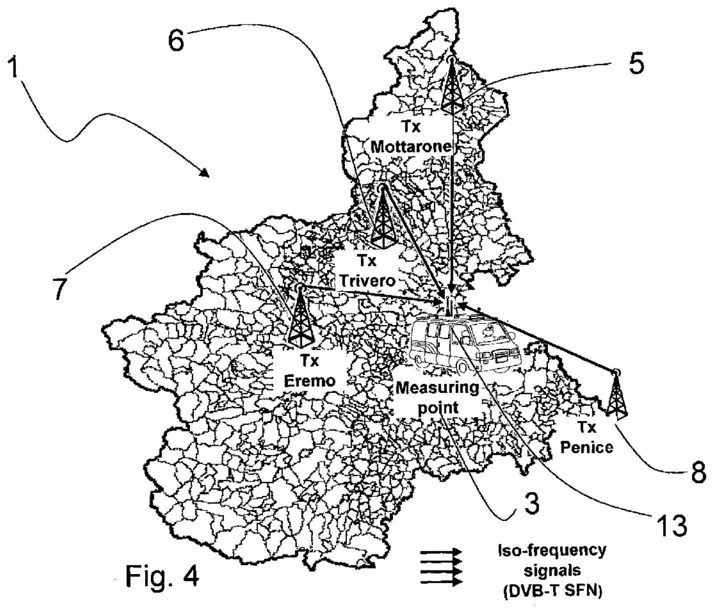

Fig. 4

(57) Abstract: A method is described for identifying transmitters (5-8) belonging to a single frequency network which transmit respective digital terrestrial radio-television signals, wherein each transmitter (5-8) transmits its own identifier coded in the service carriers of a plurality of N symbols (S40-S47) of a frame of the digital terrestrial radio-television signal, said method comprising the steps of: a) resolving, in the frequency domain and with respect to H, a linear system $Y = X \cdot H$, wherein the indexes i and j vary between 1 and N, and wherein: - Y is a vector of N elements, wherein one element Y_i of the vector Y represents a digital terrestrial radio-television signal acquired through a receiver (13) and relating to the i-th symbol of the plurality of N symbols of the frame; - X is a matrix having NxN size, wherein one element X_{ji} of the matrix X represents a signal contribution that the receiver (13) would receive if the j-th transmitter were the only one to transmit on an ideal transmission channel the digital terrestrial radio-television signal relating to the i-th symbol; - H is a vector of N elements, wherein the element H_i of the vector H represents the channel frequency response relating to the i-th transmitter; b) identifying each transmitter (5-8) through the respective identifier and the respective channel frequency response module.

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METHOD AND RECEIVER FOR IDENTIFICATION OF BROADCAST TRANSMITTERS, TRANSMITTING TERRESTRIAL DIGITAL BROADCAST SIGNALS

DESCRIPTION

The present invention relates to a method and a receiver for identifying transmitters which transmit digital terrestrial radio-television signals receivable in a given geographic point of a single-frequency DVB-T broadcasting network.

The digital terrestrial television system adopted in Europe and in many other countries in the world is called DVB-T (Digital Video Broadcasting - Terrestrial) and has been described in ETSI specification ETS300744: "Digital Video Broadcasting; Framing structure, channel coding and modulation for digital terrestrial television (DVB-T)", ETSI, 1997.

Said system is based on OFDM (Orthogonal Frequency Division Multiplex) multi-carrier modulation.

The number of carriers in the OFDM symbol can be 2048 or 8192; these two modes are commonly referred to as 2k mode and 8k mode.

As known, traditional analog television (e.g. in PAL, SECAM, NTSC systems) is broadcast to the users by means of geographic networks of circular transmitters of the "multi-frequency" type, wherein each transmitter uses a different frequency than the adjacent ones in order to avoid any interference problems.

With the introduction of DVB-T digital terrestrial television, it is now also possible to use "single frequency" networks, also known as SFN, wherein all network transmitters transmit on a single frequency signals that must be perfectly equal and synchronous, so that every receiver will pick up a series of echoes of the same signal (at worst with different power levels and different propagation delays).

This implies the use of a suitable mechanism for generating the bit stream, for distributing it to the various network transmitters, and for synchronizing the latter, as described in the ETSI TS101191 technical specification: "Digital Video Broadcasting (DVB); "DVB mega-frame for Single Frequency Network (SFN) synchronization", ETSI, 2004.

With reference to Figure 1, there is shown a time/frequency map of a frame of an OFDM signal, wherein each row represents an OFDM symbol and each cell therein represents a subcarrier.

The frame structure of the OFDM signal consists of a sequence of OFDM symbols within which the modulated data carriers, in accordance with the chosen scheme (QPSK, 16QAM or 64QAM), and a few service carriers are located.

Service carriers can be divided into two categories:

a) pilot carriers: they are transmitted at a higher power level (+2.5 dB) and are used in reception for estimating the channel response. They can be further subdivided into:

a1) Continual pilot carriers (Continual Pilots): they take fixed positions, i.e. they are repeated at the same frequencies in each symbol;

a2) Scattered pilot carriers (Scattered Pilots): they take frequency positions that vary from symbol to symbol.

b) TPS (Transmission Parameters Signalling) carriers: these are service carriers modulated with information about the transmission parameters; they use a very robust modulation (2PSK differential coding/modulation, with BCH error correction code), so that they can be received even in extreme conditions.

More in detail, TPS carriers are used for carrying the parameters relating to the transmission systems, i.e. for channel coding and modulation. 17 and 68 TPS carriers are transmitted in 2k mode and in 8k mode, respectively.

In a given OFDM symbol, all TPS carriers transmit the same bit, with differential coding. The position of the TPS carriers within the symbol is static and has been chosen according to a pseudo-random rule, so as to avoid frequency periodicity. Consequently, the exact position of the TPS carriers is specified in a table defined in the ETS 300744 specification.

TPS carriers contain service information, including:

- modulation type (QPSK, 16QAM and 64QAM);
- hierarchy information;
- guard interval;
- FEC code of the data carriers;
- transmission mode (2k or 8k).

TPS carriers are transmitted on 68 consecutive OFDM symbols, thus defining the so-called "OFDM frame".

Four consecutive OFDM frames make up a "superframe".

The reference sequence corresponding to the TPS carrier of the first symbol of each OFDM frame is used for initializing the differential modulation.

Each OFDM symbol transmits one TPS bit. The group of 68 TPS bits contained in one OFDM frame is defined as follows:

- 1 initialization bit;
- 16 synchronization bits;
- 37 information bits;
- 14 redundancy bits for error protection.

At the time when the ETS 300744 specification was issued, among the 37 information bits only 23 information bits were actually used, while the remaining 14 bits were reserved for future use and had to be set to 0.

With the introduction of the DVB-H (Digital Video Brodcasting – Handheld) standard, i.e. the system for bringing television to handheld devices), some of said 14 remaining bits have been assigned; in particular, 8 of them have been allocated for cell identification.

The details of this assignment are specified in the updated DVB-T ETS 300744 specification, i.e. ETSI ETS300744: "Digital Video Broadcasting; Framing structure, channel coding and modulation for digital terrestrial television (DVB-T)", ETSI, 2009.

The information about the transmission parameters is sent as shown in Figure 2. Bits S40-S47 transport the information relating to the cell identifier (Cell-Id) used for identifying which cell the signal is received from.

The most significant byte of the cell identifier is transmitted in the odd frames of the superframe, whereas the least significant byte of the cell identifier is transmitted in the even frames.

In this manner, by using 8 bits it is possible to map up to 65,535 different cell identifiers, equivalent to 16 bits.

The bit mapping is shown in Figure 3. If the cell identifier is not enabled, the eight bits must be set to zero.

While in the DVB-H specification the use of the cell identifier (which in said standard identifies a group of transmitters of the telephone signal) is mandatory, in the case of the DVB-T standard the cell identifier is an optional parameter. At any rate, even though not expressly specified in the DVB-T specification, it is understood that all transmitters in an SFN network have the same cell identifier value.

In many countries of the world, including Italy, the analog television system is being switched to the digital television system. This implies a number of problems, a part of which were already known from the analog systems, while others are specific of the digital world.

In particular, during the network installation and setup process and the problem monitoring and finding activities, it is very useful to be able to identify the incoming signals, i.e. to selectively identify the origin of each of the digital terrestrial radio-television signals arriving at a certain point of the network.

At present, the measuring instruments used for this purpose can only identify the most robust signal received and can only provide delay and intensity indications about the other contributions.

Since in an SFN network identical signals are transmitted at the same instant by different transmitters, the resulting effect at the receiver is similar to receiving a single signal, on which echoes are superimposed which are generated by the reflection of the signal by obstacles (buildings, mountains and the like).

The OFDM receiver incorporates an echo equalization block based on the estimation of the channel frequency response, obtained through the pilot carriers.

As known, the inverse Fourier transform of the channel frequency response is the impulse response: this property is exploited in some measuring instruments in order to provide indications about the received echoes (delay with respect to the direct signal and level).

However, such instruments do not allow for selective identification of the transmitters sending the various contributions to the received signal, corresponding to the various peaks highlighted by the impulse response, although this would be extremely useful when implementing, monitoring and maintaining an SFN network.

The use of different cell identifier values for each transmitter involved in an SFN network is a good aid in finding the origin of the main beam; however, with the current instruments it is not possible to obtain information about the origin of the other signals.

Those TPS carriers whose cell identifier bits are different generate a conflict that may lead to demodulation failure for the TPS carriers only. Nevertheless, since the modulation adopted for TPS carriers is very robust, this only happens in especially unfavourable conditions, i.e. when the received signals are iso-level. In practice this situation is extremely rare and, in any case, it has been verified that user receivers can receive correctly even when the TPS carriers are not properly demodulated.

Experience has shown, however, that some semiprofessional apparatuses, generally used by antenna installers, which use TPS carriers to obtain an estimate of the quality of the received signal on the basis of geometric criteria of the constellation points (MER, Modulation Error Ratio), are adversely affected by conflicts between cell identifiers.

It is an object of the present invention is therefore to provide a method and a receiver for identifying transmitters of digital terrestrial radio-television signals, which are adapted to identify all the transmitters of digital terrestrial radio-television signals receivable in a given geographic point of a single-frequency DVB-T broadcasting network.

The method of the present invention provides for entering a univocal identifier for each transmitter into the TPS carriers of each digital terrestrial radio-television signal.

Since it is entered into the TPS carriers, said identifier does not affect the proper demodulation by the receiver of the audio/video/data streams contained in the signal.

Thanks to the presence of different signals transmitted by different transmitters, it is possible to go back to the single frequency responses of the transmission channels on the routes defined between each transmitter and the receiver.

From frequency responses, one can go back to each transmitter, which can be identified through its own identifier contained in the transmitted signal.

Said objects are achieved through the method and the receiver for identifying transmitters of digital terrestrial radio-television signals having the features set out in the appended claims, which are intended to be an integral part of the present description.

The invention will now be described in detail in some of its preferred embodiments, which are provided herein by way of non-limiting example by referring to the annexed drawings, wherein:

- Figure 1 shows a time/frequency map of a frame of an OFDM signal;
- Figure 2 shows the use of TPS bits in an OFDM frame;
- Figure 3 shows a mapping of the TPS carriers which is useful for coding a transmitter's identifier;
- Figure 4 shows a geographic area comprising a plurality of transmitters of digital terrestrial radio-television signals belonging to a single frequency network;
- Figure 5 shows an example of the result obtained from a receiver implementing the method according to the present invention.

With reference to Fig. 4, there is shown a geographic area 1, in particular the Italian region Piedmont, which comprises a plurality of transmitters 5-8 of digital terrestrial radio-television signals belonging to a single frequency network.

In a geographic point 3 of the geographic area 1, it is desirable to know the intensity of each digital terrestrial radio-television signal receivable from each transmitter 5-8. In the example of Fig. 4, the transmitters 5-8 are called “Mottarone”, “Trivero”, “Eremo” and “Penice”.

The transmitters 5-8 that cover the geographic area 1 are so configured as to transmit each an identifier of its own, which is coded into the TPS service carriers (see Fig. 2) of a plurality of OFDM symbols of a frame of the respective digital terrestrial radio-television signal being transmitted.

In particular, the identification code may advantageously be transmitted in the symbols S40-S47.

The OFDM signal thus generated is perfectly coherent in the symbols wherein the bits of the TPS service carriers are identical, e.g. the symbols S0-S39 and S48-S53, whereas in the symbols S40-S47, wherein different bits are transmitted which relate to the identification codes of different transmitters, the OFDM signal is not perfectly coherent. More precisely, the OFDM signal is coherent in the cells that transport data (video, audio, etc.), thus ensuring perfect reception, but it is not coherent in the TPS cells, in which collisions may occur.

Let us now assume that a receiver 13 located in the geographic point 3 receives digital terrestrial radio-television signals from the transmitters 5-8.

The signals transmitted by the transmitters 5-8 are signals x(t) in the time domain, just like the signal y(t) received by a receiver 13, which is ideally shown inside a transport means used for measurement campaigns.

The signals x(t) and y(t) can be represented in the frequency domain, by applying the Fourier transform, respectively as $X(\omega)$ and $Y(\omega)$.

Considering that the transmission channel on which the signals x(t) travel from the transmitters 5-8 to the receiver 13 is affected by multipath propagation, it may be characterized by the impulse response h(t) or by the Fourier transform $H(\omega)$ of the latter, also referred to as channel frequency response.

The relation $Y(\omega)=X(\omega)\cdot H(\omega)$ therefore applies, wherein the variables X, Y and H are complex quantities and the operator "·" denotes the complex product.

Furthermore, since OFDM modulation uses a sampled data processing, with a fast Fourier transform FFT in the demodulator and the inverse thereof IFFT in the modulator, the above-mentioned variables are expressed by using a first index k for the frequency position and a second index n for the position of the symbol within the frame.

It follows that, for an OFDM signal, the above relation can be rewritten as: $Y(n,k)=X(n,k)\cdot H(n,k)$.

From an analytical point of view, the signals Y(40,k) … Y(47,k), received by the receiver

13 on the TPS cells of first index k during the symbols S40-S47 of the frame of the OFDM signal, are due to superimposition of all the signals of the plurality of transmitters of the single frequency network which arrive at the reception area of the geographic point 3. Each contribution turns out to be multiplied by its own channel frequency response. Hence, in mathematical terms:

$$Y(40,k) = X_1(40,k) \cdot H_1(40,k) + X_2(40,k) \cdot H_2(40,k) + X_3(40,k) \cdot H_3(40,k) + \ldots + X_8(40,k) \cdot H_8(40,k)$$

$$Y(41,k) = X_1(41,k) \cdot H_1(41,k) + X_2(41,k) \cdot H_2(41,k) + X_3(41,k) \cdot H_3(41,k) + \ldots + X_8(41,k) \cdot H_8(41,k)$$

$$\ldots$$

$$Y(47,k) = X_1(47,k) \cdot H_1(47,k) + X_2(47,k) \cdot H_2(47,k) + X_3(47,k) \cdot H_3(47,k) + \ldots + X_8(47,k) \cdot H_8(47,k)$$

where the subscript of the signals X_i identifies the transmitter 5-8 that the signal refers to.

For each value of k, the above equations define a linear system $Y = X \cdot H$, wherein the vector H is the unknown, and wherein:

- Y is a vector of N elements, wherein one element Y_j of the vector Y represents a digital terrestrial radio-television signal acquired through the receiver 13 and relating to the j-th symbol S40-S47 of the plurality of N symbols S40-S47 of the frame of the OFDM signal;
- X is a matrix having NxN size, wherein one element X_{ji} of the matrix X represents a signal contribution that the receiver 13 would receive if the i-th transmitter were the only one to transmit on an ideal transmission channel the digital terrestrial radio-television signal relating to the j-th symbol;
- H is a vector of N elements, wherein the element H_i of the vector H represents the channel frequency response relating to the i-th transmitter.

The linear system $Y = X \cdot H$ admits of a univocal solution, provided that the determinant of the matrix X is different from zero.

In practice, this is easily verified: if not, it is possible to go back to the most favourable case by appropriately choosing the values of the identification codes assigned to the transmitters 5-8.

Once said linear system has been solved, the frequency responses of each one of the N transmission channels of each transmitter 5-8 are obtained; the module of each frequency response represents the level information, relating to the strongest signal, at which the corresponding transmitter 5-8 is being received.

The result, therefore, is a list of the individual levels of the received signal (with values normalized to 1), each individual level being associated with its own transmitter 5-8 by means of the respective identifier. Through a pre-compiled table stored in memory means of the receiver 13, it is then possible to highlight the name and/or the geographic site of each transmitter 5-8.

The linear system as shown above is of eight equations in eight unknowns. Therefore, by solving said system one can identify, through the respective identifier, up to eight transmitters received in a geographic point 3.

Usually this value is more than adequate for practical use; however, the method can be extended by having other received signals participate in the equation system, e.g. the symbols S48-S67, and/or the symbols of the frames that carry the other eight bits of the sixteen bits that make up the identification code of each transmitter 5-8.

In this way, the number of equations, and hence of unknowns, can be extended considerably.

As an alternative, since the transmitter identifier consists of a 16-bit binary word, and therefore admits of 65,535 values plus the value zero, it is possible to proceed by trial and error, at each attempt building the matrix X by using the method as described above, but each time assuming a set of N new and different identification code values, different from those of the previous case.

It is assumed that the operations described herein are carried out on TPS carriers only, i.e. only on those values of the index k which belong to the set of said carriers.

In principle, because in a DVB-T OFDM symbol all TPS carriers are modulated with the same bit, the method according to the present invention can be applied even by using only one carrier, and therefore only one value of the first index k. If, however, one wants to increase the already high robustness to noise of the method of the present invention, it is possible to repeat the process for more than one value of the first index k and, preferably after equalization, to calculate a mean of the results thus obtained.

In order to make the method as compliant as possible with the provision of the cited ETSI document, according to which the cell identifier values Cell-id of the transmitters of an SFN network should all be equal within the same cell (group of transmitters), it is conceivable to set the identifiers of each transmitter operating in the geographic area where one wants to carry out a measurement campaign only for the time strictly necessary, and afterwards to reset the predefined value, equal for all transmitters, previously decided by the network operator.

In short, the method according to the present invention includes the following steps:

- building the matrix X, wherein each column consists of the signal $[X_i(40,k), \dots X_i(47,k)]^T$ that the receiver 13 would receive if only the i-th transmitter were transmitting on an ideal channel;
- acquiring, through the receiver 13, the received signal Y(40,k) … Y(47,k), and building the vector Y having such elements in column;
- resolving the linear system $Y = X \cdot H$ with respect to H and obtaining the vector H of the channel responses: each element of the vector H represents the channel response of each transmitter 5-8, in the same order as the columns of the matrix X;
- calculating the module of the elements of the vector H: said values are the levels, relative to that of the most intense signal, i.e. normalized to 1, of the various transmitters 5-8 in the order specified above;
- from the vector obtained in the preceding step, compiling an orderly list that associates said respective levels to the identification codes of the transmitters 5-8 involved in the method;
- from a predefined table, which associates the names and/or the geographic sites of the transmitters with the respective transmitters 5-8 in use, recording the list obtained in the preceding step;
- using the list thus obtained to label the various components of the impulse response that the measurement receiver provides in graphic format; as an alternative or in addition, presenting the list in table format.

With reference to Fig. 5, there is shown a list in table format which represents an example of the result provided by a receiver 13 implementing the method of the present invention.
The receiver 13 comprises at least one antenna adapted to receive a digital terrestrial radio-television signal, a demodulator DVB-T, a processor and memory means.
The receiver 13, located in the geographic point 3, acquires the received signal, processes it in accordance with the method of the present invention by using the processor and the memory means, and displays on its own screen, or on a screen associated therewith, both the identifier of the transmitter of the strongest signal (in this case the signal of the transmitter 7 “Eremo”) and the identifiers of the weaker signals, indicating for each of them, for example, the power of the signal, relative to that of the strongest signal, and the delay. Of course, it is possible to represent on the screen the absolute values of the

received signals or other types of processed values. Optionally, in order to carry out the above-mentioned process, one may set the identifiers of each one of the transmitters operating in the geographic area where one wants to carry out the measurement campaign only for the time strictly necessary, and then reset them to the predefined value, equal for all, previously decided by the network operator.

The features of the present invention, as well as the advantages thereof, are apparent from the above description.

A first advantage of the present invention is that all the transmitters of digital terrestrial radio-television signals receivable in a given geographic point of a single frequency network are identified.

A second advantage is that the application of the method according to the present invention does not affect the robustness of the signal being transmitted.

The method and the receiver for identifying transmitters of digital terrestrial radio-television signals described herein by way of example may be subject to many possible variations without departing from the novelty spirit of the inventive idea; it is also clear that in the practical implementation of the invention the illustrated details may have different shapes or be replaced with other technically equivalent elements.

It can therefore be easily understood that the present invention is not limited to a method and a receiver for identifying transmitters of digital terrestrial radio-television signals, but may be subject to many modifications, improvements or replacements of equivalent parts and elements without departing from the inventive idea, as clearly specified in the following claims.

CLAIMS

1. A method for identifying transmitters (5-8) belonging to a single frequency network which transmit respective digital terrestrial radio-television signals, wherein each transmitter (5-8) transmits its own identifier coded in the service carriers of a plurality of N symbols (S40-S47) of a frame of the digital terrestrial radio-television signal, said method comprising the steps of:

a) resolving, in the frequency domain and with respect to H, a linear system $Y = X \cdot H$, wherein the indexes i and j vary between 1 and N, and wherein:

- Y is a vector of N elements, wherein one element Y_j of the vector Y represents a digital terrestrial radio-television signal acquired through a receiver (13) and relating to the j-th symbol of the plurality of N symbols of the frame;

- X is a matrix having NxN size, wherein one element X_{ji} of the matrix X represents a signal contribution that the receiver (13) would receive if the i-th transmitter were the only one to transmit on an ideal transmission channel the digital terrestrial radio-television signal relating to the j-th symbol;

- H is a vector of N elements, wherein the element H_i of the vector H represents the channel frequency response relating to the i-th transmitter;

b) identifying each transmitter (5-8) through the respective identifier and the respective channel frequency response module.

2. A method according to claim 1, wherein said identifiers of said transmitters (5-8) are selected in a manner such that the determinant of the matrix X is different from zero.

3. A method according to claim 1, further comprising the step of repeating step a) for at least one more frequency value of the signal frame and of calculating the mean of the results obtained for each frequency value.

4. A method according to claim 1, wherein said identifier is coded in the bits S40-S47 of the service carriers of said frame.

5. A method according to claim 4, wherein said identifier is further coded in one or more of the bits S48-S67 of said frame.

6. A method according to claim 1, wherein during each attempt said matrix X is built by using each time a new set of different identification code values (N).

7. A method according to one or more of the preceding claims, wherein the following is displayed on a screen associated with said receiver (13): said identifier and/or the name of said transmitter (5-8); the level and/or the delay, whether relative or absolute, at/with

which the respective signal is received from said transmitter (5-8).

8. A method according to one or more of the preceding claims, wherein the identifiers of each one of said transmitters (5-8) are reset to a predetermined value, equal for all transmitters and previously defined by the network operator.

9. A receiver (13) adapted to identify transmitters (5-8) belonging to a single frequency network, which transmit respective digital terrestrial radio-television signals, wherein each transmitter (5-8) transmits its own identifier coded in the service carriers of a plurality of N symbols (S40-S47) of a frame of the digital terrestrial radio-television signal, said receiver comprising:

a) means for resolving, in the frequency domain and with respect to H, a linear system $Y = X \cdot H$, wherein the indexes i and j vary between 1 and N, and wherein:

- Y is a vector of N elements, wherein one element Y_j of the vector Y represents a digital terrestrial radio-television signal acquired through said receiver (13) and relating to the j-th symbol of the plurality of N symbols of the frame;

- X is a matrix having NxN size, wherein one element X_{ji} of the matrix X represents a signal contribution that the receiver (13) would receive if the i-th transmitter were the only one to transmit on an ideal transmission channel the digital terrestrial radio-television signal relating to the j-th symbol;

- H is a vector of N elements, wherein the element H_i of the vector H represents the channel frequency response relating to the i-th transmitter;

b) means for identifying each transmitter (5-8) through the respective identifier and the respective channel frequency response module.

10. A receiver according to claim 9, comprising means for displaying the following on a screen associated with said receiver (13): said identifier and/or the name of said transmitter (5-8); the level and/or the delay, whether relative or absolute, at/with which the respective signal is received from said transmitter (5-8).

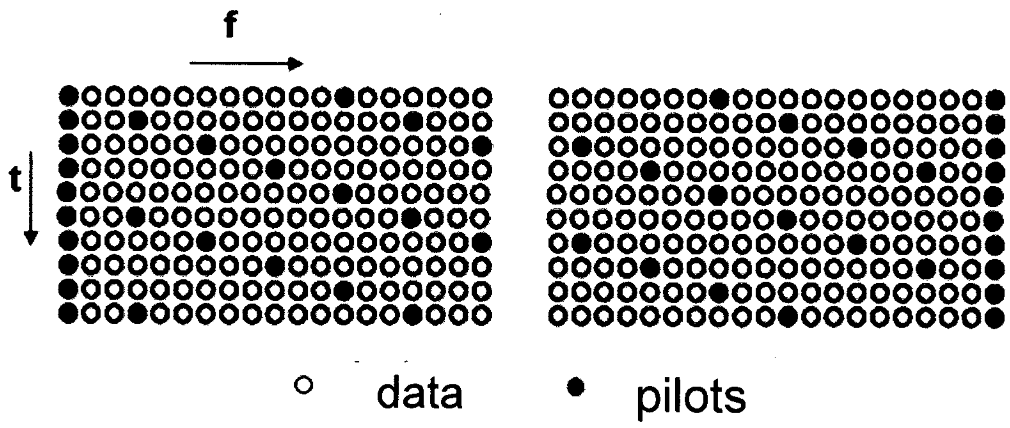

Fig. 1

Number of bits	Content
S0	Initialization
S1-S16	Synchronization word
S17-S22	Indicatore di Lunghezza
S23, S24	Frame number
S25, S26	Constellation
S27, S28, S29	Hierarchy information
S30, S31, S32	Code rate, high-priority stream
S33, S34, S35	Code rate, low-priority stream
S36, S37	Guard interval
S38, S39	Transmission mode
S40-S47	**Cell identifier**
S48-S53	Not used (set to 0)
S54-S67	Error protection code, BCH

Fig. 2

TPS bits	Frame 1 or 3	Frame 2 or 4
s40	cell_id b15	cell_id b7
s41	cell_id b14	cell_id b6
s42	cell_id b13	cell_id b5
s43	cell_id b12	cell_id b4
s44	cell_id b11	cell_id b3
s45	cell_id b10	cell_id b2
s46	cell_id b9	cell_id b1
s47	cell_id b8	cell_id b0

Fig. 3

Report of measuring instrument (example)

#	Tx	Cell-Id	P	Delay
1	Eremo	05C7	0 dB	0 ms
2	Penice	121C	-8 dB	185 ms
3	Trivero	7FA3	-15 dB	70 ms
4	Mottarone	06AF	-23 dB	95 ms

Fig. 5

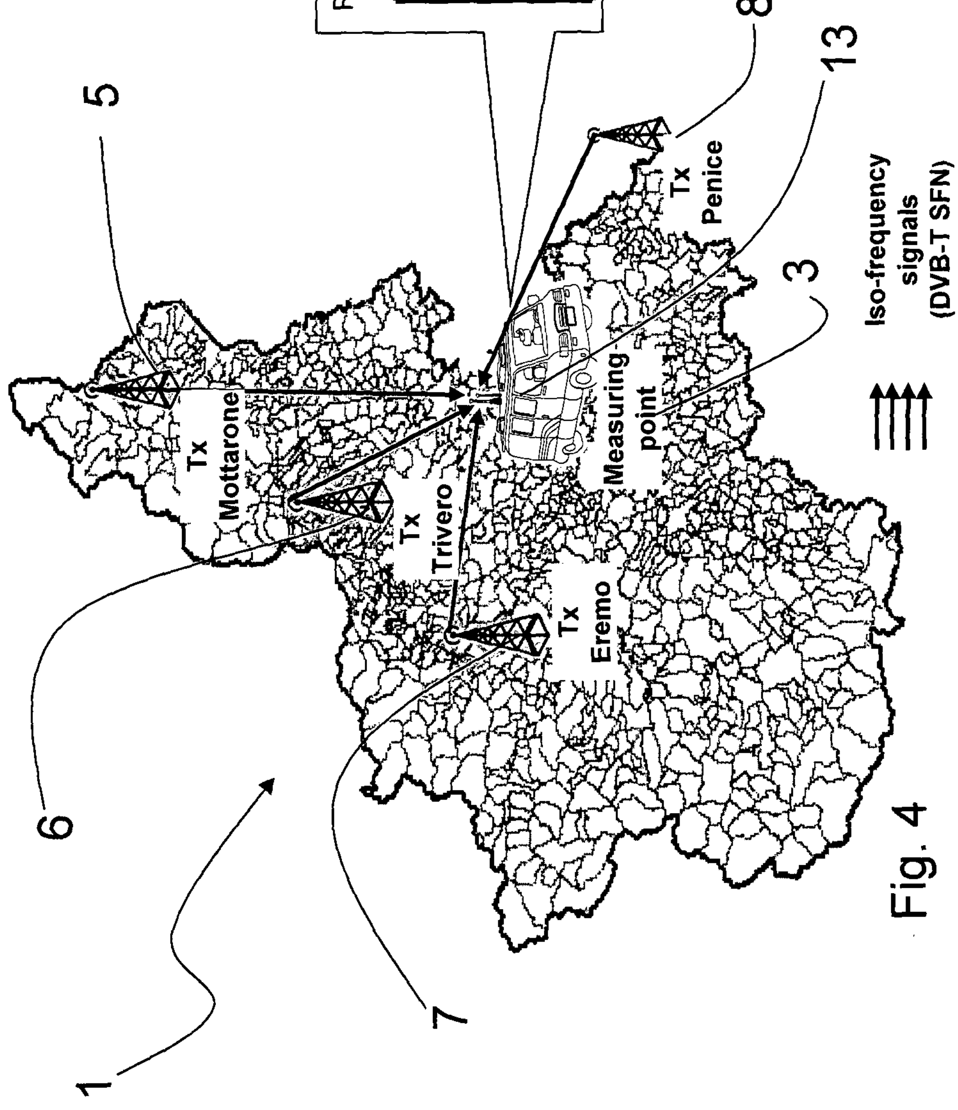

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2012/053058

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04H20/12 H04H20/67
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2004/187162 A1 (WU YIYAN [CA] ET AL) 23 September 2004 (2004-09-23) paragraph [0007] - paragraph [0010]; claims 1, 3 paragraph [0032] paragraph [0042] paragraph [0026] -----	1-10
A	WO 2009/109883 A2 (KONINKL PHILIPS ELECTRONICS NV [NL]; FILIPPI ALESSIO [NL]) 11 September 2009 (2009-09-11) page 2, line 10 - page 3, line 25; claim 1 -----	1-10
A	WO 2006/101380 A1 (SAMSUNG ELECTRONICS CO LTD [KR]) 28 September 2006 (2006-09-28) page 1, line 20 - page 5, line 32; claim 1 -----	1-10

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 September 2012	17/09/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	De Haan, Aldert

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2012/053058

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		CA 2456366 A1	30-07-2004
		US 2004150574 A1	05-08-2004
		US 2004187162 A1	23-09-2004
WO 2009109883 A2	11-09-2009	CN 101960776 A	26-01-2011
		JP 2011517874 A	16-06-2011
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		WO 2009109883 A2	11-09-2009
WO 2006101380 A1	28-09-2006	US 2006239378 A1	26-10-2006
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