

Communication device for rail vehicle, rail vehicle equipped with said device

The present invention relates to a communication device for a rail vehicle, of the type comprising a wireless communication stage to communicate with a beacon in at least one communication channel of a spectral range subdivided into several predetermined channels.

The invention applies to the field of rail security, and more particularly but not exclusively to metropolitan transportation security.

Traditionally, rail vehicles are equipped with a communication stage to communicate with beacons positioned along the railroad track.

Such beacons for example allow real-time monitoring of rail traffic.

Furthermore, such beacons for example make it possible to convey multimedia content, in particular video surveillance streams, or multimedia content for passengers of the rail vehicle.

The communication between the beacons and the communication stage generally has electromagnetic waves for its medium, in particular waves whose frequency is in the 2400 MHz-2489.5 MHz band or beyond 5 GHz, in particular the 5250 MHz-5350 MHz and 5470 MHz-5725 MHz bands. Such frequency ranges are generally not assigned exclusively, and are for example freely used by mobile devices for the general public, such as mobile telephones, tablets or laptop computers.

The presence of a large number of such mobile devices on board a car of a rail vehicle, in particular near the communication stage, for example during peak hours, may disrupt or even interrupt communication between the communication stage and the beacons. Safe travel conditions are such that if on board - ground communication is broken, the rail vehicle must stop.

Thus, the disruption by travelers' terminals of on board - ground communication in particular results in a temporary interruption in the travel of the rail vehicle, which reduces the quality of service offered to users.

Such a disruption also deteriorates the quality of the multimedia data stream intended for the rail vehicle, or even causes the interruption of such a stream.

One aim of the invention is to propose a communication device making it possible to achieve better reliability and better availability of on board - ground communication, in particular for rail communication devices operating in the 5250 MHz to 5350 MHz frequency band, as well as the 5470 MHz to 5725 MHz frequency band.

The usage conditions for these two frequency bands are defined, in Europe, by standard ETSI EN 301,893 (for example, in its current version bearing reference V 1.7.2 published in July 2014) and, in other parts of the world, by similar standards.

To that end, the invention relates to a communication device for a rail vehicle, of the aforementioned type, characterized in that it further includes a protection stage connected to a protection antenna, the protection antenna being able to capture radio waves propagating in at least one car of said rail vehicle, the protection stage being able to detect the frequency of the waves captured by the protection antenna and, if said frequency belongs to at least one communication channel, to generate signals interfering with the or each communication channel and apply them to the protection antenna, the protection antenna also being able, from said interference signals, to radiate radio interference waves in said car.

Third-party devices, as previously described, are then no longer able to occupy the channels on which the protection stage emits signals.

According to specific embodiments, the invention has one or more of the following features, considered alone or according to any technically possible combinations:

- the characteristics of the or each channel are defined by standard ETSI EN 301893 and/or standard IEEE 802.11, preferably standard IEEE 802.11a, still more preferably in its version referenced 1999, revised in June 2003;

- the communication device is configured to communicate with communication beacons according to the communication protocol whose characteristics are defined by one of standards IEEE 822.11, preferably standard IEEE 802.11a;

- the interference signals are radar signals, for example radar signals as described in standard ETSI EN 301893;

- the protection stage is connected to the communication stage to send information relative to the generated interference signals;

- the protection stage is able to determine the MAC address of the device having emitted the captured waves, and said protection stage being able to generate interference signals if said MAC address is different from a predetermined MAC address, preferably different from a MAC address associated with the communication stage;

- the protection stage and the protection antenna are adapted so that the interference waves radiated by the protection antenna have a power greater than or equal to -62 dBm in the car;

- the protection stage and the protection antenna are protected so that the interference waves radiated by the protection antenna have a power less than or equal to -70 dBm at a communication antenna of the communication stage.

The invention also relates to a rail vehicle, characterized in that it comprises a communication device as defined above.

The rail vehicle can comprise the following feature:

- the protection antenna is able to radiate toward at least one of the cars of the rail vehicle that are situated near the installation of the communication stage of the communication device on board the rail vehicle.

The invention will be better understood using the following description, provided solely as an example and done in reference to the appended drawings, in which:

- figure 1 is a diagram of a rail vehicle comprising an example embodiment of a communication device according to the invention;

- figure 2 is a diagrammatic illustration of a protection stage of the communication device of figure 1;

- figure 3 is a spectrum diagrammatically showing the power radiated in certain channels of the spectral range, when the protection stage of the communication device of figure 1 is inactive;

- figure 4 is a spectrum similar to the spectrum of figure 3, given when the protection stage is active.

The wireless communication device 5 illustrated by figure 1 is positioned on board a rail vehicle 10. The communication device 5 is able to communicate without contact with beacons 15 positioned along a railroad track 17 for travel of the railroad vehicle 10. The communication between the communication device 5 and the beacons 15 is done aerially through the beacon antennas 25.

The beacons 15 are able to provide the rail vehicle 10 with instructions relative to the travel of the rail vehicle 10 on the railroad track 17, for example signaling information.

Furthermore, the beacons 15 are able to convey multimedia content between the communication device 5 and a computer unit on the ground. In particular, the beacons 15 are able to convey video surveillance streams between the rail vehicle 10 and the computer unit on the ground, or multimedia content for passengers of the rail vehicle 10.

The communication beacons 15 are able to communicate with the communication device 5 in a predetermined spectral range, also called "communication range". Preferably, the communication range is subdivided into a plurality of predetermined channels, the beacons 15 and the communication device 5 being able to communicate with one another at a communication frequency belonging to at least one of said channels, also called "communication channel".

Preferably, the communication range is a radio frequency band. The communication range is for example chosen from the group consisting of: the band from

5250 MHz to 5350 MHz and the band from 5470 MHz to 5725 MHz. The usage conditions for such bands are defined by standard ETSI EN 301893.

The subdivision of the communication range into channels is preferably defined by standard ETSI EN 301893 and standard IEEE 802.11a, standard ETSI EN 301893 defining the central frequency of each channel, and standard IEEE 802.11a defining the width of each channel. In the 5250 MHz-5350 MHz and 5470 MHz-5725 MHz bands, the channels have a spectral width of 20 MHz. The data signals exchanged between the communication device 5 and the communication beacons 15 occupy all of at least one channel of the communication range, a channel having an extended width of 20 MHz.

Preferably, the communication device 5 and the communication beacons 15 are suitable for communicating according to a communication protocol whose characteristics are defined by one of standards IEEE 802.11, preferably standard IEEE 802.11a, still more preferably in its version referenced 1999, revised in June 2003.

The rail vehicle 10 includes cars 27 for receiving passengers. Some of the passengers of the cars 27 use mobile communication devices 28 able to operate on the same frequency band as the communication device 5.

The communication device 5 includes a communication stage 30. The communication device 5 also includes protection means 32 comprising a protection stage 35 and a protection antenna 40.

The protection stage 35 is connected to the communication stage 30. The protection stage 35 is further electrically connected to the protection antenna 40.

The communication stage 30 includes a transceiver module 50 and a communication antenna 55.

The transceiver module 50 is able to communicate with the beacons 15 via the communication antenna 55, by free propagation between the communication antenna 50 and the beacon antennas 25. In particular, the transceiver module 50 is able to communicate with the beacons 15 via signals whose spectrum is comprised in a communication channel as defined above.

Alternatively, the beacons 15 have no antenna and are each associated with at least one waveguide positioned near the railroad track 17. The transceiver module 50 is then able to communicate with the beacons 15 via the communication antenna 55, by electromagnetic coupling between the communication antenna 55 and each waveguide.

The communication stage 30 is able to send the protection stage 35 information relative to the predetermined communication channel that is used for the communication of the transceiver module 50 with the beacons 15.

Alternatively, each beacon 15 defines a cell associated with a predetermined communication channel, two successive cells being associated with different communication channels. The communication stage 30 is then able to communicate with the beacons 15 in each of the corresponding communication channels. Thus, as the rail vehicle 10 progresses along the railroad track 17, the communication stage 30 successively communicates with each beacon 15 in the corresponding communication channel. The communication stage 30 then sends the protection stage 35, in real-time, information relative to the communication channel used at the current moment, for communication of the communication stage 30 with the beacons 15.

Furthermore, the communication stage 30 is able to send the protection stage 35 information relative to the MAC address of the transceiver module 50.

The protection antenna 40 is positioned in an end car 60 of the rail vehicle 10.

The protection antenna 40 is for example a coaxial cable whereof the shielding has been altered to allow the cable to radiate part of the electric signals supplied to it in the form of radio waves in transmission mode, and to allow the cable to transform part of the captured waves into electric signals in reception mode.

The antenna 40 is preferably able to radiate signals primarily toward the end cars 60 of the rail vehicle, situated near the installation point of the communication device 5 on board the rail vehicle 10.

The protection antenna 40 is also able to capture electric waves that propagate in the end car 60 and to send, to the protection stage 35, an electric signal corresponding to the captured waves, also called "captured signal".

As illustrated in figure 2, the protection stage 35 includes a transceiver coupler 62 connected by a non-radiating electric connection 64 to the protection antenna 40.

The protection stage 35 includes, downstream from the coupler 62 operating in reception mode, a reception module 66 able to receive the captured signal coming from the protection antenna 40.

The protection stage 35 includes a detection module 68, downstream from the receiving module 66, able to detect the frequency of the received signal.

The protection stage 35 includes an identification module 70, downstream from the detection module 68, able to detect the MAC address associated with a received signal whose frequency is situated in the communication band of the communication device 5.

The protection stage 35 includes an interference module 72 connected to the coupler operating in transmission mode. The interference module 72 is able to generate a radar signal, also called "interference signal", whose frequency corresponds to the communication channel currently used by the communication stage 30. Within the

meaning of the present application, "interference signal" refers to a radio signal for radar applications as described in the standards governing the allocation of wireless resources in the considered communication band. Such radar signals are for example radar signals for military applications. For example, in Europe, such radar signals are described in standard ETSI EN 301893. In particular, the protection stage 35 is able to send an interference signal having a spectrum comprised in the communication channel.

The interference module 72 is connected to the detection module 68 and to the identification module 70 to receive the frequency of the received signal and the detected MAC address, respectively.

The interference module 72 is further connected to the communication stage 30 to receive the MAC address of the transceiver module 50 and information relative to the current communication channel.

Preferably, the interference module 72 is able to generate the interference signal if the frequency of the captured signal belongs to the communication channel and if the MAC address of the device that emitted the wave corresponding to said captured signal is different from the MAC address of the transceiver module 50.

Alternatively, the interference module 72 is able to generate the interference signal only if the frequency of the captured signal belongs to the communication channel.

In still another alternative, the interference module 72 is able to generate the interference signal during a period of time preceding the use of the communication channel by the communication device 5.

Furthermore, the coupler 62 is able to apply the interference signal, via the non-radiating link 64, to the protection antenna 40, the protection antenna 40 then being able to radiate part of the interference signal in the end car 60.

Preferably, the protection means 32 are adapted so that the waves corresponding to the interference signal and that are radiated by the protection antenna 40 have a power greater than or equal to -62 dBm within the car 60.

Furthermore, the protection means 32 are suitable for the waves corresponding to the interference signal and that are radiated by the protection antenna 40 to have a power less than or equal to -70 dBm at the communication antenna 55 of the communication stage 30.

The communication device 5, whose operation is illustrated by figures 3 and 4, works in at least one range among the 5250 MHz-5350 MHz and 5470 MHz-5725 MHz frequency ranges. These ranges are subdivided into a plurality of predetermined channels according to standard ETSI EN 301893 and standard IEEE 802.11a, standard ETSI EN 301893 defining the central frequency of each channel, and standard IEEE 802.11a

defining the width of each channel. According to standard IEEE 802.11a, the channels have a width of 20 MHz.

The communication stage 30 is able to send and receive signals in a predetermined communication channel B3, chosen from among the channels in the 5470 MHz-5725 MHz band. In these figures, the signals exchanged between the communication stage 30 and the beacons 15 are shown by vertical lines in the frequency range.

According to standard IEEE 802.11a, the mobile devices 28 transmit in a plurality of channels, for example a first channel B1, a second channel B2 and the communication channel B3. In these figures, the signals sent and/or received by the mobile devices 28 are shown by horizontal lines in the frequency range.

During operation, during the progression of the rail vehicle 10 on the railroad track 17, the communication stage 30 communicates with the successive beacons 15.

If the protection antenna 40 captures an electric wave, the captured electric signal corresponding to said electric wave is conveyed toward the protection stage 35.

The protection stage 35 detects the frequency of the captured signal. The protection stage 35 also detects the MAC address of the electronic device that sent the wave corresponding to the captured signal.

If the detected frequency belongs to the communication channel B3, and if the detected MAC address is different from the MAC address of the transceiver module 50, the protection stage 35 generates a radar interference signal as defined above, and the spectrum of which is comprised in the communication channel B3.

The interference signal is next conveyed to the protection antenna 40. The protection antenna 40 then radiates at least part of the interference signal in the end car 60.

Upon receipt of the interference signal, the mobile devices 28 cease to communicate on the communication channel B3, according to standard ETSI EN 301893. Furthermore, according to said standard ETSI EN 301893, the mobile devices 28 can no longer use the communication channel B3 during a half-hour beginning from the reception time of the interference signal.

Consequently, in order to communicate, the mobile devices 28 located in the end cars 60 can use any channel of the communication range except the communication channel B3.

The power of the interference signal at the communication antenna 55 being less than or equal to -70 dBm, according to standard ETSI EN 301893, the communication stage 30 is not disrupted by the interference signal.

Consequently, the communication channel B3 is only occupied by the data exchanged between the communication stage 30 and the beacons 15.

Advantageously, alternatively, the protection stage 35 is also able to send information relative to the interference signal to the communication stage 30.

5 In that case, when the communication antenna 55 receives a radar signal whose spectrum is comprised in the communication band B3, the transceiver module 50 uses information received from the protection stage 35 to determine whether said interference
10 signal has been generated by the protection stage 35. If the captured radar signal has been generated by the protection stage 35, then the communication stage 30 ignores said radar signal and continues to communicate with the beacons 15 in the communication band B3.

CLAIMS

1.- A communication device (5) for a rail vehicle (10), of the type comprising a wireless communication stage (30) for communicating with a beacon (15) in at least one communication channel (B3) of a communication range subdivided into several predetermined channels (B1, B2, B3),

said communication device (5) being characterized in that it also includes a protection stage (35) connected to a protection antenna (40),

the protection antenna (40) capturing radio waves emitted by a mobile device (28) and propagating in at least one car (27, 60) of said rail vehicle (10),

the protection stage (35) detecting the frequency of the waves captured by the protection antenna and, if said frequency belongs to said at least one communication channel (B3), generating interference signals on said at least one communication channel (B3) and applying them to the protection antenna,

the protection antenna (40) radiating from said interference signals, interference radio waves in said car (27, 60), so that said mobile device (28), in order to communicate, can use any channel of the communication range except said at least one communication channel (B3).

2.- The communication device (5) according to claim 1, characterized in that the characteristics of each channel (B1, B2, B3) are defined by the standard ETSI EN 301893 and/or one standard of the standards IEEE 802.11, preferably the standard IEEE 802.11a.

3.- The communication device (5) according to claim 2, characterized in that said communication device (5) is configured to communicate with the beacon (15) according to a communication protocol whose characteristics are defined by one standard of standards IEEE 802.11, preferably the standard IEEE 802.11a.

4.- The communication device (5) according to any one of the preceding claims, characterized in that the interference signals are radar signals, for example radar signals according to the standard ETSI EN 301893.

5.- The communication device (5) according to any one of the preceding claims, characterized in that the protection stage (35) is connected to the communication stage (30) to send information relative to the interference signals generated.

6.- The communication device (5) according to any one of the preceding claims, characterized in that the protection stage (35) determines the MAC address of the mobile device (28) having emitted the waves captured, and in that said protection stage (35) generates interference signals when said MAC address is different from a predetermined MAC address, preferably different from a MAC address associated with the communication stage (30).

7.- The communication device according to any one of the preceding claims, characterized in that the protection stage (35) and the protection antenna (40) are adapted so that the interference radio waves radiated by the protection antenna (40) have a power greater than or equal to -62 dBm in the car (60).

8.- The communication device (5) according to any one of the preceding claims, characterized in that the protection stage (35) and the protection antenna (40) are protected so that the interference radio waves radiated by the protection antenna (40) have a power less than or equal to -70 dBm at a communication antenna (55) of the communication stage (30).

9.- A rail vehicle (10), characterized in that it comprises a communication device (5) according to any one of claims 1 to 8.

10.- The rail vehicle (10) according to claim 9, characterized in that the protection antenna (40) is able to radiate toward at least one of the cars (60) of the rail vehicle (10) that are situated near the installation of the communication stage (30) of the communication device (5) on board the rail vehicle (10).