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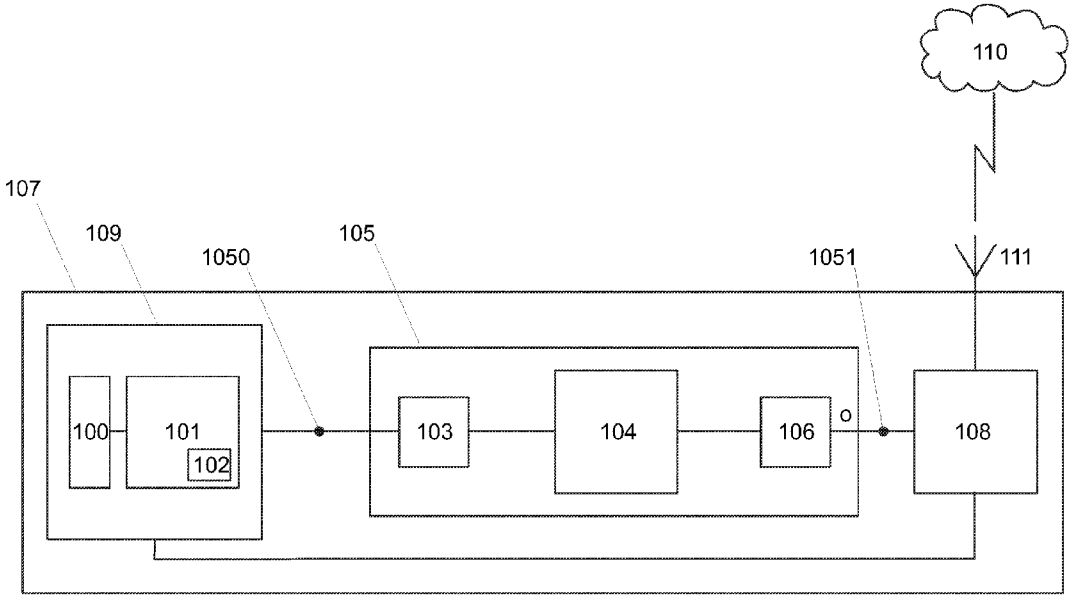


Fig. 1

(57) Abstract: A cellular tracking device (107) comprising a communication module (109), an antenna module (108) and a circuit (105) for limiting the emissions of a tracking device (107), said circuit (105) comprising: a connection input (1050) for connecting to a communication module (109) of the tracking device (107);an output connection (1051) for connecting to an antenna module (108) of the tracking device (107);a guard circuit (103) for periodically interrupting an emission of an output signal at the output connection, thus preventing the tracking device (107) to continuously transmit;a signal limiter (106) for trimming said output signal (o) when the power of said output signal exceeds a predefined threshold.

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# A circuit for limiting the emissions of a cellular tracking device

## Field of the invention

**[0001]** The present invention concerns a circuit to prevent the radio transmission activity of a cellular tracking device to interfere with avionics while aboard a flight vessel.

## State of the art

**[0002]** With the emergence of the Internet of things and the decrease of hardware prices, shipments of any kinds get more and more tracked.

**[0003]** Delivery companies and clients sending shipments, such as packages or containers, often need to know where a shipment is located at a given moment. This information improves the visibility of the shipment service e.g. the estimated arrival of the shipment can be determined and delivery problems can be determined earlier. For the client, the actual location of his shipment gives him more insight, if the shipment is on its way, on the correct way and when it will arrive. Solutions exist that can even send information about the status of a shipment, like its temperature or whether it has been opened, enabling to receive alarms on deviations.

**[0004]** Therefore, shipment tracking/tracing systems have been created. As an example, existing container tracking systems provide each container with a unique code, which is scanned at certain check-points. The location of the container is determined based on the location of the check-point. The unique codes are scanned by barcode scanners or automatically with RFID scanners, for example. However, this solution has the drawback that all check-points must be equipped with scanners and that the determination of the present container location depends on the availability of the check-points, which is limited. Also, the location of the container will only be known with good accuracy right after the scan has been made. Especially, once a container is on a vehicle, its position remains unknown

until it is scanned at the next station where the container is taken off from the vehicle. Therefore, during the transportation time within the same vehicle, there is no location information available. E.g. the information that the container has been sent with the wrong vehicle is only available at the next check-point.

**[0005]** Other tracking services provide each shipment with a global positioning system (GPS) tracking device. The GPS provides the GPS tracking device with a position of the shipment with a very high precision. GPS has the disadvantage that the location is only determined in the GPS tracking device; therefore, an additional link for communicating the position to the user is required if the user or the location processing system is at a remote location. Moreover, the GPS signals are weak, and they are usually not available when obstructed inside buildings or inside vehicles. The battery autonomy is usually limited.

**[0006]** Alternatively, a location can be determined with Wi-Fi signals, and possibly trilateration. This solution only works if the shipment is within reach of one or multiple hotspots and only if the position of these hotspots is known.

**[0007]** Cellular tracking devices have also been proposed by the applicant and by other companies. Those devices use a cellular transceiver, such as a GSM module, both for determining the position of the device, based on the position of the closest base stations and possibly on trilateration, and for transmitting this position to a remote server. Those devices offer an extended coverage, indoor and outdoor, thanks to the ubiquity of cellular networks. The autonomy is very important, especially if the cellular tracking device has no display and emits only intermittently.

**[0008]** One important drawback of such cellular tracking devices is they are not allowed to transmit their position from an airplane because it is well known that cellular devices may interfere with avionic control equipment in the vicinity and alter their functions.

**[0009]** Therefore, according to flight legislation, those devices, and more generally all transmitting personal electronic devices (T-PEDs), are required to have their transmitting emitter switched off unless it is proven that they are harmless to aircrafts and provided the operator allows them. Failing to do so may compromise the security of the aircraft and have dramatic consequences.

**[0010]** According to the Joint Aviation Authorities Regulations Jar Ops 1.110, "*An operator shall not permit any person to use, and take all reasonable measures to ensure that no person does use, on board an airplane a portable electronic device that can adversely affect the performance of the aeroplane's systems and equipment*". The requirements for the performance of the aeroplane's avionics are defined in the document "RTCA DO-160 Environmental Conditions and Test Procedures for Airborne Equipment".

**[0011]** Solutions for preventing use of cellular phones within aircrafts have been suggested, US2014364053 suggests a system and a method for masking GSM signals within an aircraft. This masking of signals is not authorized in many countries and may actually create additional interferences for the electronic equipment in the aircraft. It also makes the use of a GSM tracking device impossible from the aircraft.

**[0012]** FR2985114B1 discloses a mobile phone comprising a first high-power radiofrequency transmitter and a second, reduced power radiofrequency transmitter that can be activated instead of the high-power radiofrequency transmitter to reduces interferences from an airplane. This mobile phone offers a limited communication ability even from sensible area where communications are usually not allowed. However, the safety depends on a manipulation that the user needs to do when entering the plane. Moreover, having two radiofrequency circuits increases the cost and volume of the device.

**[0013]** EP1966906B1 discloses a method and a device for communicating with reduced power. The method comprises sending a request to a base station for establishing a low power transmission. Again, the safety depends on a deliberate manipulation of the user.

**[0014]** Other solutions have been proposed to automatically switch off personal electronic devices in aircrafts. Some use accelerometers, others motion sensors while others sense the proximity of aircrafts.

**[0015]** EP1287376 describes several means of sensing the proximity of a vessel, including sensing the aircraft transponder, sensing the sonic waves formed by the jet engines, sensing pressure flight characteristics, detecting the position with GPS and comparing the position with known airfields positions, detecting tags surrounding aircrafts (e.g. beacons). However, these solutions require several sensors to work reliably, so they need redundancy to switch off reliably and therefore add cost to the device and use a lot of battery. Furthermore, most of the solutions in this document switch off the communication module too late, when the aircraft is already airborne.

**[0016]** WO2011063285 describes a mean of detection based on acceleration. However, the solution described requires a 3-axis accelerometer, which is power-consuming. Moreover, the solution describes the detection of the flight phase with "sufficient vertical acceleration". However, in this case, the aircraft is already airborne and therefore, the detection occurs too late.

**[0017]** WO2013044399 describes a mean of detection based on acceleration data. However, by doing so, the one must first reliably characterize the vibration of an aircraft, and the characteristics will only work on a limited set of aircrafts that have been tested. Alternatively, the tracker can be switched off as soon as some vibrations are detected. However, in this case, the tracker will also not communicate whilst in movement outside an aircraft.

**[0018]** WO20130245986 describes a solution to characterize the flight by collecting continuously motion data and comparing it with typical vehicular movement. However, to determine with certainty whether the detected movement is generated by an aircraft is difficult; this method is not deemed to be reliable.

**[0019]** US2016260058 discloses a method relating to monitoring cargo. It uses an accelerometer device, and may include an adaptation of the sending power.

**[0020]** US20140308940 describes a solution to switch the operation mode of mobile phone based on detected pressure and comparing it with typical aircraft atmospheric pressure. However, this solution requires an exact characterization of all aircrafts cabin pressures. Moreover, it would not work on non-pressured aircrafts or helicopters.

**[0021]** More generally, these solutions suffer from several drawbacks.

**[0022]** The major is that they are dependent on the environment they are in and may not detect take-offs reliably and early enough. For example, an accelerometer might fail to detect a smooth take off, or a helicopter take-off. An HF-environment sensor might be surrounded by material that attenuate the signal strength and thus fail to detect vessel proximity.

**[0023]** Another drawback of those solutions is that they require several additional components that increase final cost and possibly energy consumption of the device.

## Brief summary of the invention

**[0024]** An aim of the invention is to provide a device and a method that overcome the above-mentioned problems of the prior art.

**[0025]** In particular, an aim of the present invention is to provide a cellular tracking device that cannot adversely affect the airworthiness of any flying vessels, like aircrafts or helicopters.

**[0026]** Preferably, the safety of the tracking device is independent from any sensor.

**[0027]** According to the invention, those aims are achieved with a circuit for limiting the emissions of a cellular tracking device, comprising:

a connection input for connecting to a communication module of the cellular tracking device;

an output connection for connecting to an antenna module of the cellular tracking device;

a guard circuit for authorizing or interrupting an emission of an output signal, thus preventing the cellular tracking device to continuously transmit;

a signal limiter for trimming said output signal when the power of said output signal exceeds a predefined threshold.

**[0028]** In this application, we define "cellular tracking device" as a device whose main function is to track items or persons, and in which the position of the item, and the transmission of this position to a remote equipment, is based on a cellular network, for example a GSM network or similar.

**[0029]** The circuit is intended to be connected to the output of a communication module of a cellular tracking device. It prevents the cellular tracking device to emit in such a way that it could interfere with the avionics. Thanks to a combination of a signal limiter (to avoid a strong signal to be sent out) and a guard circuit (to prevent constant or other irregular transmission), the device can be guaranteed to never emit strongly or continuously enough to be a danger for an aircraft.

**[0030]** The circuit is preferably a discrete circuit, comprising one or a plurality of electronic components distinct from the communication module. Therefore, the safety only depends on this circuit, and is independent of the communication module.

**[0031]** Therefore, only the circuit needs to be certified to be authorized in aircrafts.

**[0032]** The guard circuit is preferably adapted for authorizing or blocking an emission of the output signal according to an authorized emission pattern.

**[0033]** In one embodiment, the guard circuit is adapted for authorizing an emission of the output signal during a first predetermined interval of each of a plurality of periods, and for blocking emission of the output signal during the remaining time in each of said periods.

**[0034]** The guard circuit can comprise a set of components for blocking transmission during undesired transmission periods.

**[0035]** The guard circuit may comprise another set of components for blocking transmission in some frequency bands.

**[0036]** In one embodiment, the signal limiter circuit comprises two zener diodes which are mounted in parallel and in opposite direction between the output of the power amplifier and the ground signal. The breakdown voltage of the zener diode is selected to limit the maximum power that can be generated to stay below levels that should not be exceeded according to flight legislation.

**[0037]** The signal limiter is constantly applied to the power amplifier output signal and does not depend on any external sensor signal. Since it

cannot be controlled by software, the certification of the device does not require any software certification.

**[0038]** The power amplifier is preferably mounted downstream of the guard circuit and upstream of the signal limiter.

**[0039]** The power amplifier and the signal limiter may be integrated into one circuit.

**[0040]** A cellular tracking device may comprise a first set of electronic components, including the communication module and the antenna module. The emission limited radio circuit preferably comprises a second set of electronic components distinct from the components of the first set.

**[0041]** The power amplifier may include a configurable amplification factor. This amplification factor may be controlled by the communication module and is preferably configured in such a way that the output power of the power amplifier will never exceed a level which could affect the airworthiness of aircrafts.

**[0042]** The communication module may further comprise a protocol controller for controlling the emission of signal. The protocol controller may be synchronized with the guard circuit to avoid transmission during blocking windows, and to ensure that the signal cancellation performed by the guard circuit does not interrupt a signal in the middle of a valid frame.

Brief Description of the Drawings

**[0043]** The invention will be better understood with the aid of the description of an embodiment given by way of example and illustrated by fig. 1 that shows a schematic view of the preferred embodiment.

Detailed Description of possible embodiments of the Invention

**[0044]** Fig. 1 shows an example of a cellular tracking device 107.

**[0045]** In a first embodiment, the cellular tracking device 107 may be a mobile phone of a tracked person. For example, parents could have an interest to track a child travelling alone.

**[0046]** In another embodiment, where an item such as a container, a cargo container or any other shipment must be tracked, the cellular tracking device 107 is preferably a dedicated device that is closed within, connected in any way to or attached to the item, such that the tracking device 107 can be associated with the item. In this embodiment, the tracking device 107 is preferably a voiceless device, i.e., a device that is only able to send or receive data but no voice. As such, it is preferably free of any keypad, loudspeaker, microphone and/or display.

**[0047]** In one embodiment, buttons, a small display or LEDs, and/or a loudspeaker may be available to provide a limited user interface for the configuration and settings. Alternatively, or in addition, the configuration and settings may also be entered and/or displayed with a remote device, such as a smartphone or computer, connected to the tracking device over a wireless interface, such as the cellular interface or an additional wireless interface such as Wi-Fi, Bluetooth, ZigBee or NFC. In one embodiment, the tracking device could be in a credit card format.

**[0048]** The following description will focus on this embodiment of a cellular tracking device 107 for tracking items, such as shipments.

**[0049]** In one embodiment, the tracking device 107 comprises a communication module 109, a circuit 105, such as an emission limited radio circuit 105 and an antenna module 108.

**[0050]** The communication module 109 is used to collect information about the available radio networks 110 and to perform communication tasks with the radio network 110. The communication module 109 is for example a receiver for Global System for Mobile Communication (GSM), Universal Global Communications System (UMTS), Long Term Evolution (LTE), etc., or any other electronic module adapted for establishing a data connection with a radio network, such as a cellular network 110.

**[0051]** The tracking device 107 can establish a communication through the radio network 110, for example a phone call, a text message (e.g. SMS), GPRS, special system messages, broadcasting messages, or any other message or communication sent through the radio network 110.

**[0052]** The communication module 109 comprises logic, circuitry and/or code operable to transmit, receive, encode and decode wireless radio signals in accordance with one or more radio communication standards and/or protocols, for example a standard for radio communication with mobile phones like for example GSM, UMTS, LTE. The communication module 109 may further be configured to establish a connection with the radio network 110.

**[0053]** The communication module 109 comprises a battery (not shown), a microcontroller 100, a baseband controller 101 and a protocol controller. The microcontroller 100 includes or is connected with memory for storing for example an operating system, such as Unix or Android, and a plurality of software modules that can be executed by the microcontroller. One software module might be provided for collecting information about antennas that can be detected from the cellular network. This information can include but is not limited to antenna identity, antenna position, network type, antenna frequency, signal power and signal delay. Another software module might be provided for transmitting this information to a remote server or equipment over the radio network 110.

**[0054]** The baseband controller 101 comprises suitable logic, circuitry and/or code for establishing a communication with the radio network 110.

**[0055]** Additionally, the tracking device 107 might comprise sensors, such as temperature sensors, accelerometers, humidity sensors, etc. (not shown) for monitoring the tracked item. Some of those sensors, and other sensors, such as a clock or a light sensor, might be used to wake up the device and/or to switch it into a low power and no emission mode, depending on measured signals.

**[0056]** Additionally, the tracking device 107 might comprise radio signal reception circuitry for other signals such as Wi-Fi, Bluetooth, Zigbee, GPS, etc. Information about these signals may be collected and sent over the radio network 110 to a remote server.

**[0057]** The antenna module 108 is any circuitry to connect the emission limited radio circuit 105 with an antenna 111 and may comprise non-amplifying suitable logic, circuitry and/or code operable to transmit radio frequency signals from and to the radio network 110.

**[0058]** The emission limited radio circuit 105 is an additional circuit that is connected between the communication module 109 and the antenna module 108. It may comprise one or a plurality of discrete electronic components, distinct from the component(s) that form the communication module 109 and the antenna module 108.

**[0059]** One function of the emission limited radio circuit 105 is to prevent emission over the antenna 111 that exceed the prescriptions, for example prescriptions for use in an airplane.

**[0060]** The emission limited radio circuit 105 is preferably a single hardware component, or a set of components on a printed circuit board.

All components can be made of analog circuits only. Alternatively, at least some of those components comprise digitally controlled analog circuits.

**[0061]** The emission limited radio circuit 105 preferably comprises a connection input 1050 for connecting it to the communication module 109, and a connection output 1051 for transmitting its output signal o to the antenna module 108. The input and/or the output can comprise pins for welding the circuit 105 onto a printed circuit board for example.

**[0062]** In a preferred embodiment, the emission limited radio circuit comprises a guard circuit 103, a power amplifier 104 and a signal limiter 106.

**[0063]** The guard circuit 103 may ensure that the cellular tracking device 107 can only emit during time limited sending windows, for example according to a duty cycle (e.g. 1 second per hour), or according to a predefined pattern. This will ensure that the cellular tracking device 107 will never emit in continuous mode. In a preferred embodiment, the guard circuit 103 authorizes outgoing signals during a first predetermined interval of each of a plurality of periods, and blocks the emission of the output signal o during the remaining time in each of said periods. For example, the guard signal authorizes emission of the outgoing signal o during less than 2 minutes each hour, or preferably less than 30 seconds each hour, and blocks the outgoing signal the rest of the time. The duration of authorized emission is chosen to be sufficient for establishing a connection with the closest base station, and to send one message.

**[0064]** The authorization period is preferably longer than one minute, preferably longer than five minutes, for example one hour. This will ensure a tracking of the item with a granularity sufficient for most needs, while reducing the duration of emission to a minimum. Other duty cycles, and other non-periodical patterns of authorization/blocking might also be considered.

**[0065]** The guard circuit 103 may also ensure that the tracking device 107 can only emit in one or a plurality of authorized frequency band (e.g. for GSM: 850MHz, 950MHz, 1800MHz and 1900MHz bands). It can comprise a band filter for filtering all signals outside of the authorized frequency band(s).

**[0066]** The power amplifier 104 is connected to the output of the guard circuit 103, and amplifies the signals authorized by the guard circuit 103. The power amplifier is thus mounted downstream of the guard circuit 103 and upstream of the signal limiter 106. Since the guard circuit 103 blocks the emission most of the time, the power amplifier can only consume power during short periods of time.

**[0067]** The signal limiter 106 is connected to the output of the power amplifier 104. It is preferably composed of analogic electronic components.

**[0068]** The signal limiter 106 prevents emissions above an authorized level even if the communication module 109 in conjunction with the power amplifier 104 intends to emit above this level. The signal limiter thus ensures that the power signal transmitted from the power amplifier 104 to the antenna module 108 which in turn transmits its power to the antenna 111 will never exceed the maximum power with which an aircraft has been certified. The maximal authorized power may for example result in a magnitude of the electric field generated by the antenna being less than a predefined threshold, for example 1V/m.

**[0069]** The signal limiter 106 and the power amplifier 104 may be combined into a single amplifier whose emitting power is limited to a threshold. This is advantageous since it avoids the waste of power that would result from amplifying a signal first and then trimming this signal in a subsequent signal limiter 106. This will also ensure that the signal limiter 106 does not distort the emission to the antenna 111. However, a separate signal limiter may be safer and easier to certificate than an amplifier with maximal emitting power.

**[0070]** In an alternative embodiment, the power gain is controlled by the baseband controller 101 which is configured to limit the power gain of the power amplifier 104 below a threshold. This is again advantageous since it avoids wasting power and creating signal distortion.

**[0071]** In addition, the guard circuit 103 ensures that only authorized signals may be provided to the input of the power amplifier 104. The safety is therefore independent from the communication module 109 and of the power amplifier 104. Therefore, only the specific emission limiting circuits 103 and 106 needs to be verified and/or certified to authorize the use of the device in aircrafts.

**[0072]** The emission limited radio circuit 105 only needs to block outgoing signals; signals received by the antenna module 108 may be relayed to the communication module without any interruption, and independently of the frequency band. It is thus possible to receive information about available antennas which are used to determine the location of the device 107, and to save this information, even during periods where emission is blocked. Therefore, incoming signals bypass the emission limited radio circuit 105 and are transmitted directly from the antenna module 108 to the communication module 109, as indicated with the line on the Figure.

**[0073]** The authorization pattern of the guard circuit 103, i.e., the ratio between blocking periods and authorization periods, may be changed and adapted for example depending on the intended use, or depending on signals received by the sensors or over the radio network. In one example, the duty cycle is reduced so that the emission time during each period is limited when signals from sensors or from a remote server indicate that the tracking device is, with a high probability, in an airplane, and increased to emit more frequently when the tracking device is less likely to be in an airplane, and/or when it is close to the place delivery, and/or when other events have been detected. A change of duty cycle may also be triggered

from a remote server or administrator. Alternatively, transmission on demand may be initiated with a button on the device 107.

**[0074]** During a typical communication cycle, the communication module 109 will request its baseband controller 101 to establish communication with the network according to the protocol specification. The guard circuit 103 monitors the transmitting signal and controls that this signal is transmitted according to a protocol in time; signals outside the authorized transmission windows are suppressed.

**[0075]** If the guard circuit 103 has decided to block the transmission of its input signals to the power amplifier 104, it may pursue this blocking during a period, for example for 1 hour, to ensure that radio energy levels stay at very low levels even when multiple cellular tracking devices 107 are inside the same aircraft for example.

**[0076]** The protocol controller 102 is preferably synchronized with the guard circuit 103, to avoid attempts to transmit during blocking windows, and to allow that the signal blocking performed by the guard circuit may avoid the interruption of a signal in the middle of a valid frame.

**[0077]** The signal at the output of the guard circuit 103 is amplified by the power amplifier 104. The signal limiter 106 trims down any emission going above a predefined level, thus ensuring the emission cannot have adverse effects on the aircraft. Further, the signal o is emitted to the radio network 110 by the antenna module 108.

**[0078]** This embodiment has the advantage that the cellular tracking device 107 will always communicate according to the protocol standard and below susceptibility level of any critical component of an aircraft. This makes the cellular tracking device harmless to any aircraft, and thus being generically certifiable for the usage on any aircraft.

**[0079]** Another benefit is that the safety is ensured by the guard circuits 103 and signal limiter 106 only. Those circuits are relatively simple and their certification is much easier than the certification of a complete communication module 109.

**[0080]** Another benefit is that the reception path of the signals from the antenna module 108 to the communication module 109 is not degraded. The signal limiter 106 only has an effect when high power signals are present and will have a negligible effect on the sensitive input signals that are present for the reception path. The guard circuit 103 does not intervene in the reception path at all.

**[0081]** Another benefit is that the guard circuit 103 and the signal limiter 106 are permanently switched on and do not depend on sensors. Therefore, they do not represent a risk of late detection of critical airworthiness related flight phases for example.

**[0082]** A further advantage of this embodiment is that if the aircraft is equipped with a communication access point, e.g. a GSM pico-cell, the cellular tracking device 107 will be able to communicate with this access point.

**[0083]** In another embodiment, the emission is controlled by the protocol controller 102. In order to avoid the guard 103 being activated all the time, the GSM baseband controller 101 will be steered by the protocol controller 102. The protocol controller 102 may be a software module.

## Reference Numbers

| | |
|---|---|
| 100 | Microcontroller |
| 101 | Baseband controller |
| 102 | Protocol controller |
| 103 | Guard circuit |
| 104 | Power amplifier |
| 105 | Emission limited radio circuit |
| 106 | Signal limiter |
| 107 | Cellular tracking device |
| 108 | Antenna module |
| 109 | Communication module |
| 110 | Radio network |
| 111 | Antenna |
| 1050 | Connection input |
| 1051 | Connection output |
| o | Output signal |

## Claims

1. A circuit (105) for limiting the emissions of a cellular tracking device (107), comprising:

a connection input (1050) for connecting to a communication module (109) of the tracking device (107);

an output connection (1051) for connecting to an antenna module (108) of the tracking device (107);

a guard circuit (103) for authorizing or interrupting an emission of an output signal (o) at the output connection, thus preventing the tracking device (107) to continuously transmit;

a signal limiter (106) for trimming said output signal (o) when the power of said output signal exceeds a predefined threshold.

2. The circuit of claim 1, said guard circuit being a pattern guard circuit arranged for authorizing respectively blocking the emission of the output signal according to an authorized emission pattern.

3. The circuit of claim 2, said pattern guard circuit being arranged for authorizing the emission of the output signal during a first predetermined interval of each of a plurality of periods, and for blocking the emission of the output signal during the remaining time in each of said periods.

4. The circuit of claim 1, consisting of one or a plurality of electronic components, said input connection (1050) and said output connection (1051) consisting of pins.

5. The circuit of any one of the claims 1 to 4, said guard circuit (103) being further adapted for authorizing emission of a signal within one predefined frequency band, and for blocking any emission of signal outside of said predefined frequency band.

6. The circuit of one of the claims 1 to 5, said signal limiter comprising two zener diodes mounted in parallel and in opposite direction between a line that transmits the output signal and the ground signal, wherein the breakdown voltage of the zener diode is selected to limit the maximum power that can be emitted.

7. The circuit of one of the claims 1 to 6, comprising a power amplifier (104) for amplifying said output signal, said power amplifier being mounted downstream of the guard circuit and upstream of the signal limiter.

8. The circuit of one of the claims 1 to 7, comprising a power amplifier, the power amplifier and the signal limiter being integrated into one discrete circuit.

9. A cellular tracking device (107) comprising:
a communication module (109);
a circuit (105) according to one of the claims 1 to 7;
an antenna module (108).

10. The cellular tracking device of claim 9, said communication module (109) comprising a first set of electronic components and said circuit (105) comprising a second set of electronic components distinct from the components in the first set.

11. The cellular tracking device of one of the claims 9 to 10, said communication module (109) further comprising a protocol controller (102) for controlling emission of signal,
said protocol controller (102) being synchronized with the guard circuit (103), to avoid transmission during blocking windows, and to ensure that the signal cancellation performed by the guard circuit does not interrupt a signal in the middle of a valid frame.

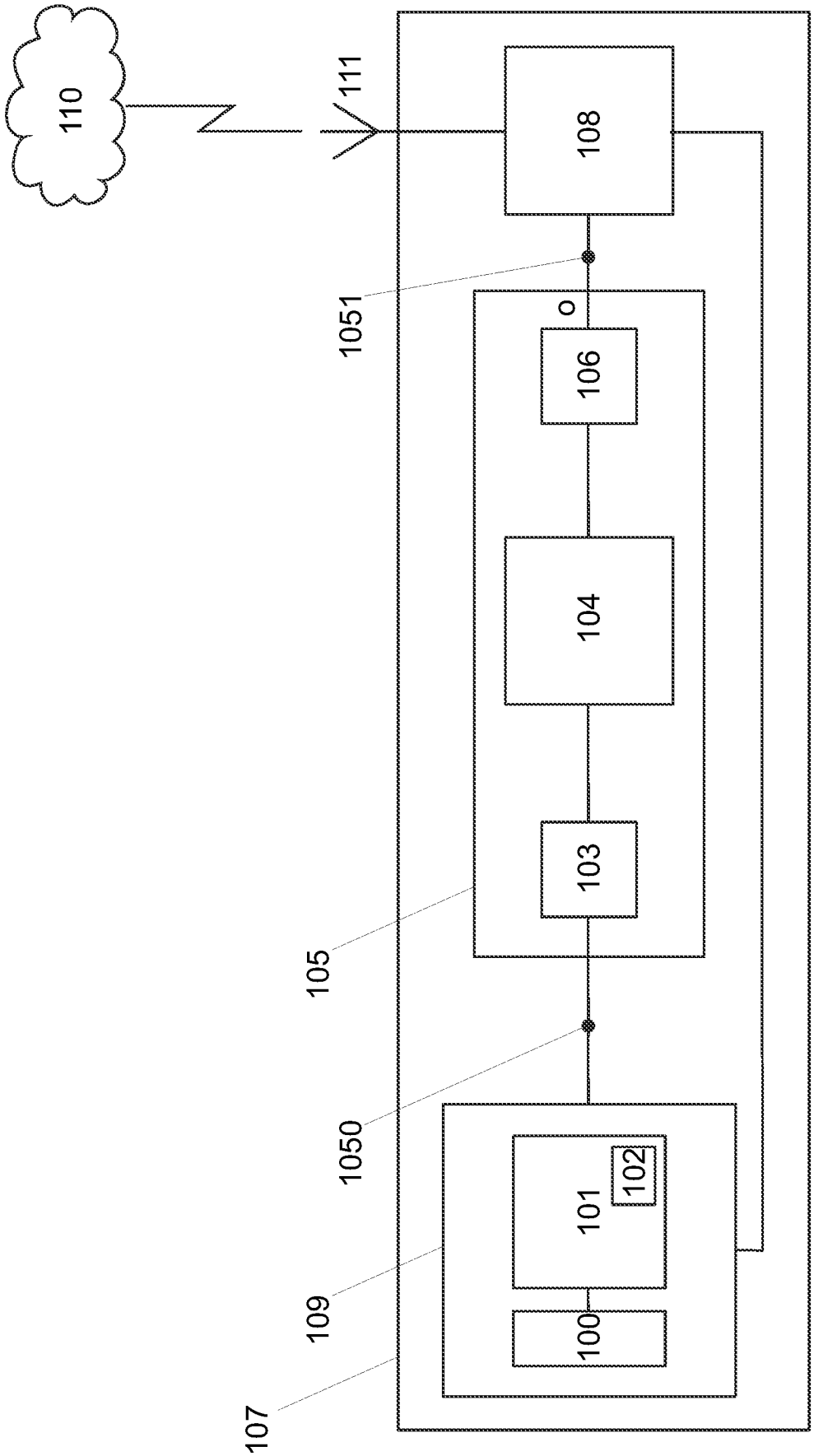


Fig. 1

# INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2018/059213

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04K3/00 H04W52/28 H04M1/725 H04W52/30 H04W52/24
H04B7/185 H01Q1/28 H04B1/3822 B64D45/00 H04W52/02
H04W52/38 H04W48/04 H04W4/30 H03G11/02 H03G11/00

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)
H04K H04W H04M H04B H01Q B64D H03G

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, COMPENDEX, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | WO 2013/044399 A1 (SWISSCOM AG [CH]; RIEM-VIS RUUD [CH]; SPAETH BERTRAND [CH]; TOME PHILI) 4 April 2013 (2013-04-04) cited in the application | 1-4,6-11 |
| A | page 4, line 24 - line 28<br>page 6, line 18 - page 7, line 7<br>page 8, line 8 - page 9, line 6<br>page 13, line 16 - page 14, line 11<br>page 16, line 11 - page 17, line 22<br>page 18, line 3 - page 19, line 4<br>page 19, line 16 - page 20, line 11<br>page 20, line 23 - page 21, line 15;<br>figure 15 | 5 |

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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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 |
|---|---|
| 18 January 2019 | 29/01/2019 |

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

# INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2018/059213

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | US 2015/031318 A1 (MCCALLISTER RONALD DUANE [US]) 29 January 2015 (2015-01-29) | 1-4,6-11 |
| A | paragraph [0001]<br>paragraph [0033] - paragraph [0050]; figure 3<br>paragraph [0051] - paragraph [0063]; figure 4<br>paragraph [0071] - paragraph [0078] | 5 |
| | --- | |
| Y | JP S62 190912 A (YOKOGAWA ELECTRIC CORP) 21 August 1987 (1987-08-21)<br>abstract; figure 1 | 6-8 |
| | --- | |
| A | WO 01/75472 A2 (MARCONI CORP PLC [GB]) 11 October 2001 (2001-10-11)<br>cited in the application<br>page 1, line 11 - page 2, line 4<br>page 2, line 11 - line 17<br>page 3, line 11 - line 14<br>page 9, line 1 - line 8<br>page 19, line 1 - line 14 | 1-11 |
| | --- | |
| A | EP 3 228 542 A1 (GREIG NIGEL [NZ]; KEOWN MARK [NZ]) 11 October 2017 (2017-10-11)<br>paragraph [0033]<br>paragraph [0064] | 1-11 |
| | --- | |
| A | US 2014/364053 A1 (SCHIRRMACHER MARTIN [DE]) 11 December 2014 (2014-12-11)<br>cited in the application<br>paragraph [0010] - paragraph [0012]<br>paragraph [0025]<br>paragraph [0029] - paragraph [0032] | 5 |
| | --- | |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2018/059213

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| WO 2013044399 A1 | 04-04-2013 | NONE | |
| US 2015031318 A1 | 29-01-2015 | NONE | |
| JP S62190912 A | 21-08-1987 | NONE | |
| WO 0175472 A2 | 11-10-2001 | AU 4668701 A | 15-10-2001 |
| | | EP 1287376 A2 | 05-03-2003 |
| | | JP 2003529777 A | 07-10-2003 |
| | | KR 20030022107 A | 15-03-2003 |
| | | US 6281797 B1 | 28-08-2001 |
| | | US 2002017989 A1 | 14-02-2002 |
| | | WO 0175472 A2 | 11-10-2001 |
| EP 3228542 A1 | 11-10-2017 | EP 3228542 A1 | 11-10-2017 |
| | | US 2017310543 A1 | 26-10-2017 |
| US 2014364053 A1 | 11-12-2014 | DE 102011119892 A1 | 29-05-2013 |
| | | EP 2786616 A1 | 08-10-2014 |
| | | US 2014364053 A1 | 11-12-2014 |
| | | WO 2013079512 A1 | 06-06-2013 |