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DETECTING PASSING RFID TAGS IN A SPORTS EVENT

Abstract

The present invention relates to a detection assembly (**102**) for detecting passing sports timing transponders (**14**) in a sports event, comprising: an antenna (**106**) and a calculation unit (**104**) connected to the antenna; and a channel element (**22**) for positioning the antenna and the calculation unit on an underlying surface and for protecting the antenna and the calculation unit from external forces, wherein said channel element is connectable to a preceding channel element (**108**) and a following channel element (**110**) to form a line; said calculation unit is connectable to a first neighboring calculation unit (**112**) via a first cable (**114**) extending into the preceding channel element and to a second neighboring calculation unit (**116**) via a second cable (**118**) extending into the following channel element; and said calculation unit includes a voltage detection circuitry (**124**) for detecting whether power is provided to the calculation unit via the first cable or via the second cable. The present invention further relates to a floor cable channel (**20**) and a race timing system (**16**).

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Background/Summary

[0001] The present invention relates to a detection assembly for detecting passing sports timing transponders in a sports event. The present invention further relates to a floor cable channel and a race timing system.
[0002] In the field of timing at sports events, for example running events, marathons, bicycle races, skiing races, car races, horse races or others, timing of participants' start, finish, and split times plays an important role. In prevailing timing systems, oftentimes a person, a vehicle or an animal, whose time is to be measured, carries a radio element (sports timing transponder, in particular an active or passive RFID tag) for non-contact, automated timing. Runners, for instance, may carry radio elements that are attached to shoe laces or to a bib number for being pinned to the participant's shirt or pants.
[0003] At start, finish and split time positions along a track, measuring points are provided to detect the presence of the radio element and determine a passing time, i.e. a moment in time at which the radio element passes the measuring point. For this purpose, a measuring point usually comprises a corresponding antenna and data processing means to process the received data. Usually, the determined passing times for the participants are then communicated to a central evaluation point for access by the organizers of the event and the participants.
[0004] In this context, a sports timing transponder particularly designates a radio element that is able to transmit and receive radio signals. A sports timing transponder may refer to a passive RFID tag that has no integrated energy source or to an active RFID tag with an included battery. In the case of a passive RFID tag, the sports timing transponder is usually activated, i.e. read out, upon passing a measuring point, by a corresponding RFID reader that can determine the passing time based on one or multiple reads. In the case of an active RFID tag, usually an inductive loop is detected by the tag and a passing time is calculated in the tag based on multiple detections to be transmitted to a corresponding apparatus for further processing and/or evaluation.
[0005] Current sports timing systems for passive RFID tags usually include a suitcase-sized apparatus (usually referred to as decoder) comprising the RFID reader. This decoder is connected to a corresponding RFID antenna. The antenna is often a ground antenna that is integrated in a cable channel, or a side antenna that is positioned at a side of a race track on a tripod. Apart from the RFID reader, which is usually an RFID reader originally intended for logistics applications, current decoders include at least a battery, a processing module and different options for communication.
[0006] In this context, WO 2016/188798 A1 relates to a floor cable channel for positioning a cable line element on an underlying surface and for protecting the cable line element. Two channel elements are configured for receiving the cable line element and for being connected by means of a connection element. The floor cable channel can be brought into a transport position and into an operating position in which the channel elements are arranged one behind the other along their longitudinal axes. There is further disclosed a floor antenna including the floor cable channel as well as an electrical conductor and an antenna. Still further, there is disclosed a timing system

including a ground antenna, a mobile transponder and a mobile base station.

[0007] Relevant drawbacks of current solutions are oftentimes their limited flexibility with respect to the deployment at the location of the sports event as well as the complexity for setting up the race timing system. Usually, application scenarios require the sports timing system to be installed as quickly and as easily as possible. Oftentimes, the exact location of start, finish and split time positions, the circumstances at these locations and in particular the width of the race track at the location are not known beforehand. Furthermore, only limited time is available for setting up the system. Still further, the personnel setting up the system oftentimes includes unskilled workers that have no or little specific experience. In view of this, a flexible and simple way to set up the race timing system is relevant.

[0008] In view of the above, the present invention addresses the problem of providing a flexible to use and easy to set up race timing system. In particular, the desired race timing system should allow for accommodating different widths of the race track, should limit the impact of errors or mistakes upon installation due to misuse or lack of experience of the set-up personnel and should be robust against environmental impacts from changing weather conditions or mechanical stress.

[0009] To solve this problem, a first aspect of the present invention relates to a detection assembly for detecting passing sports timing transponders in a sports event, comprising: [0010] an antenna and a calculation unit connected to the antenna; and [0011] a channel element for positioning the antenna and the calculation unit on an underlying surface and for protecting the antenna and the calculation unit from external forces, wherein [0012] said channel element is connectable to a preceding channel element and a following channel element to form a line; [0013] said calculation unit is connectable to a first neighboring calculation unit via a first cable extending into the preceding channel element and to a second neighboring calculation unit via a second cable extending into the following channel element; and [0014] said calculation unit includes a voltage detection circuitry for detecting whether power is provided to the calculation unit via the first cable or via the second cable.

[0015] In another aspect the present invention relates to a floor cable channel comprising multiple detection assemblies as defined above connected to one another to form a line.

[0016] Yet another aspect of the present invention relates to a race timing system including a floor cable channel as defined above and a decoder connected to a calculation unit of the first and/or second detection assembly in the line. The decoder is configured to synchronize operation of the connected detection assemblies, preferably based on positions of the detection assemblies in the line.

[0017] Preferred embodiments of the invention are defined in the dependent claims. It shall be understood that the claimed floor cable channel and race timing system have similar and/or identical preferred embodiments as the claimed detection assembly, in particular as defined in the dependent claims and as disclosed herein.

[0018] The present invention is based on the idea of making the set-up of the race timing system at the location of a sports invent more flexible. The detection assembly of the present invention includes a channel element in which an antenna and a calculation unit are mounted. The channel element protects the antenna and the calculation unit from external forces such as environmental impacts due to wind and weather conditions, but also mechanical impacts for example from participants in a running event stepping onto the channel element or cars, trucks and other vessels traversing the channel element.

[0019] According to the invention the calculation unit is connectable to neighboring calculation units in further channel elements to form a chain of calculation units. The channel element is connectable to preceding and following channel elements to form a line of channel elements. Multiple detection assemblies connected in this manner form a floor cable channel. The connection between calculation units thereby particularly refers to an electrical connection for data and/or power transfer via cable (in particular multiple wires in a cable), whereas the connection between channel elements refers to a mechanical connection for mechanical stabilization.

[0020] The voltage detection circuitry of the calculation unit allows detecting whether a supply voltage is provided to the calculation unit via one of the first cable and the second cable. It can additionally be possible that it is detected from which one of the neighboring calculation units power is provided. Based on the information whether power is provided, it becomes possible to communicate with the other calculation units and, in particular, with a decoder connected to one of the calculation units, preferably at one end of the chain of calculation units or the cable channel, respectively. By providing this detection function for detecting whether power is provided to the calculation unit via the first cable or via the second cable it becomes possible to flexibly connect detection assemblies to form a floor cable channel of definable length to accommodate the circumstances at the desired set-up position. A desired number of channel elements can be connected to one another upon setup and with little or no prior installation effort.

[0021] In comparison to previous approaches the present invention thereby facilitates the set-up procedure of a race timing system on site at an event. In particular, it becomes possible to combine a number of detection assemblies to form a floor cable channel of adaptable length. Different widths of race tracks can be accommodated without prior specification by connecting an appropriate number of detection assemblies. In addition, an easy reconfiguration becomes possible which results in higher reliability and resilience against environmental impacts. Upon failure of one detection assembly simple replacement is possible. The decoder can be connected on either side of the floor cable channel to further facilitate setup.

[0022] In an embodiment the calculation unit includes a data bus circuitry to provide a data bus communication with further calculation units of further detection assemblies connected via the first cable and via the second cable in a daisy chain. Preferably, the data bus circuitry is configured to provide a controller area network (CAN) bus communication. A daisy chain thereby corresponds to a wiring scheme in which multiple calculation units are wired together in sequence to form a chain of calculation units. A serial connection and a serial communication is provided. Each one of the calculation units in the chain is connected to its neighbors on both sides. The CAN bus protocol was originally developed for use in automotive applications. However, the CAN bus protocol can also be used in other applications. In the present invention, it has been recognized that a CAN bus communication, i.e. the use of the CAN bus protocol, provides the necessary functions for connecting multiple detection assemblies. Alternatively or additionally to making use of a CAN bus, it is also possible to use other systems, such as RS-485 or Powernet. In comparison to previous approaches in which each detection assembly is separately connected to the decoder, the cabling is minimized to safe costs and allow for easy and efficient reconfiguration. By making use of a standard bus protocol the reliability of the implementation can be improved.

[0023] In an embodiment the calculation unit includes a terminal detection circuitry for detecting whether the calculation unit is connected to only one of the first neighboring calculation unit and the second neighboring calculation unit. Preferably, the terminal detection circuitry is configured to switch a resistor to terminate a data bus when it is detected that the calculation unit is not connected to the first neighboring calculation unit and/or to the second neighboring calculation unit. In bus systems, it is usually required that the bus is terminated so that the communication can be established. In the present invention this bus termination is implemented via the terminal detection circuitry. Thereby, this terminal detection circuitry allows flexible reconfigurability. In particular, it can be recognized whether a connection to a further detection assembly is established or not. For this, the terminal detection circuitry may be configured to repeatedly perform a respective detection in regular intervals. During operation, a determination whether only one calculation unit is connected allows for a detection of defects. For instance, the terminal detection circuitry makes it possible to detect if a detection assembly fails. Then a corresponding reaction can be triggered, for instance by informing an operator. In comparison to previous approaches with a predetermined number of detection assemblies the use of the terminal detection circuit makes it possible to flexibly reconfigure the communication during use. A highly flexible race timing system is obtained.

[0024] In an embodiment the calculation unit includes a position detection circuitry for detecting a first number of calculation units connected via the first cable and/or a second number of calculation units connected via the second cable. This again results in a detection of a position of the calculation unit in the daisy chain. In other words, it becomes possible that the calculation unit detects its own location in the chain of calculation units thereby enabling an efficient communication between the calculation units. In comparison to previous approaches with multiple detection assemblies combined to form a line, the position detection circuitry enables a simple communication scheme and a flexible reconfiguration, also at runtime. A robust operation and a detection of failures becomes possible.

[0025] In an embodiment the calculation unit includes a reconfiguration circuitry for detecting a change in a first number of calculation units connected via the first cable and/or a second number of calculation units connected via the second cable. This detection allows for a reconfiguration at runtime. For instance, if one detection assembly in the floor cable channel fails or needs to be replaced, the reconfiguration circuitry allows for the communication to be reestablished. By detecting a change in a number of calculation units it becomes possible to reconfigure the communication if necessary. A robust operation becomes possible.

[0026] In an embodiment the voltage detection circuitry is configured to determine from which one of the first cable or the second cable power is provided. Additionally or alternatively, the voltage detection circuitry is configured to initialize a through connection to provide power to the respective neighboring calculation unit. It is possible that the voltage detection circuitry determines from which side power is provided. Further, it is possible that a through-switching of the power is implemented. In other words, a power connection is established between corresponding wires of the first cable and the second cable. This has the advantage that an automated and flexible setup becomes possible.

[0027] In an embodiment the calculation unit includes a communication circuitry for communicating with a decoder connected via the first cable or the second cable. In particular, the detections of sports timing transponders can be communicated to the decoder for further processing and/or for being provided to the participants in the sports event. Thereby, the communication circuitry can particularly be suitable for the data bus communication.

[0028] In an embodiment the communication circuitry is configured to receive from the decoder a synchronization signal for synchronizing operation of the calculation units in the line. Additionally or alternatively, the communication circuitry is configured to receive from the decoder a position information indicating a position of the calculation unit in a chain of calculation units from the point of view of the decoder. A synchronized operation thereby particularly refers to sequentially activate and deactivate calculation units in order to avoid interference between RFID readers that are within interference range of one another. If two spatially neighboring RFID readers are operated at the same time (transponders read out at the same time), it is possible that these interfere with one another. This can result in a decreased detection rate. In order to avoid this, the operation of the calculation units in the chain can be synchronized. For instance, it is possible that only every second calculation is operated at the same time slot to increase the spatial distance between simultaneously operated RFID readers in circuitry. The detection rate is improved and reconfiguration and a flexible setup are possible.

[0029] In an embodiment the calculation unit includes a defect detection circuitry for detecting a defect in the calculation unit and for establishing a direct connection between the first cable and the second cable. Preferably, the defect detection circuitry is configured to provide a defect information to a decoder connected via the first cable or the second cable. In cases in which the calculation unit fails (i.e. some functions do not function properly any more), it has to be assured that the communication in the line of detection assemblies can still be maintained. For this, the defect detection circuitry determines whether the calculation unit itself has a relevant defect, in particular a defect that has an effect on the communication with the neighboring calculation units, and, in this case, establishes a direct connection. Thus, in other words, the defect calculation unit is skipped in the communication. It is possible that the decoder is provided with an information about which detection assembly fails (e.g. timeout function) so that the position of the other detection assemblies as used in the decoder can be appropriately updated.

[0030] In an embodiment the calculation unit includes an RFID reader circuitry for detecting passing RFID tags in spatial vicinity of the antenna and determines a corresponding passing time. Preferably, the RFID reader circuitry is configured to determine the passing time based on an evaluation of a phase change of a detection. The RFID reader circuitry is integrated in the detection assembly and in the channel element. In other words, a decentralized RFID reader set-up with dedicated reader circuitry for each antenna is proposed. This makes it possible that only the cumulated data representing a read or a passing time have to be communicated from the calculation unit to the decoder for further processing. Consequently, the amount of data to be communicated is reduced. A further advantage of this decentralized set-up is an improved robustness due to not having a single point of failure in a central reader. In addition to making use of a signal strength for determining the passing time it is also possible to determine the passing time based on an evaluation of a phase change. In other words, a shift in the phase caused by the movement of the transponder in the direction of the detection assembly or away from the detection assembly is evaluated and used as an input for determining the passing time, i.e. the point in time at which the RFID tag is at a minimum distance from the antenna. In particular, it is possible to detect a change of sign or a zero crossing. The evaluation of the phase change of the detection can thereby result in an improved accuracy of the passing time detection.

[0031] In an embodiment the channel element includes a first connection portion for connecting the channel element to the preceding channel element and a second connection portion for connecting the channel element to the following channel element. Further, the channel element includes a center protection area for receiving the antenna. Still further, the channel element includes a first protection area for receiving the first cable, wherein the first protection area is designed to connect the center protection area to the first connection portion, and a second protection area for receiving the second cable, wherein the second protection area is designed to connect the center protection area to the second connection portion. Still further, the channel element includes a bypass protection area for receiving a cable, wherein the bypass protection area is designed to connect the first connection portion to the second connection portion.

[0032] A channel element has a center protection area in which an antenna can be received and housed to be protected from external forces such as mechanical impact or also weather impact. This center protection area is connected to both connection areas via corresponding protection areas. In the protection areas cables can be housed for the connection of the components in the center protection area to components in other channel elements. In addition to the first and second protection areas the channel element of the present invention provides a bypass area that is designed to house a cable that directly connects the two neighboring channel elements, preferably without interfering with the center protection area.

[0033] The channel element of the present invention (mechanically) connects to a preceding channel element on one side and to a following channel element on the other side. A plurality of channel elements can be connected to one another in a line. A channel element having therein an antenna and a calculation unit is referred to as a detection assembly. Multiple detection assemblies can be connected in a line to form a floor cable channel.

[0034] In a line of detection assemblies, the calculation units in the different detection assemblies can be connected (to establish a data and/or power connection between neighboring calculation units) via cables running through the first and second protection areas and the bypass protection area(s). Thereby, neighboring calculation units are located in detection assemblies having another detection assembly arranged between them. A cable in the bypass area allows connecting the first protection areas of the preceding and following channel elements. A cable running through the bypass protection area thereby makes it possible that every second calculation unit is connected. Thus, two substantially independent chains of calculation units can be obtained, with one chain including every second calculation unit

[0035] In an embodiment of the detection assembly the calculation unit is connectable to the first cable and/or the second cable by means of a first connector part and a second connector part that are designed for being screwed together to establish an electric connection, in particular an electric connection having four conductors. Preferably, the first connector part and the second connector part include printed circuit boards. Preferably, the first connector part and/or the second connector part include at least one pogo pin for establishing the electric connection upon being screwed together. Preferably, the first connector part includes a threaded connector for receiving a screw, in particular a soldered threaded connector and the second connector part includes a hole for the screw. Preferably, the first connector part and/or the second connector part are designed for holding a sealing in between for protecting the electric connection from moisture. In order to transfer electric signals from one calculation unit to the next a reliable connection is required, in particular if multiple calculation units are arranged in a line of detection assemblies. The first connector part can be located at the side of the calculation unit and, e.g., connected to the calculation unit via conducting paths on a printed circuit board. The second connector part can be located at the side of the cable and soldered to one or more conductors of the cable. Usually, the connector parts provide a connection of multiple electrical conductors (signal paths). A screw is used to connect the two connector parts by screwing them together. In comparison to plug-and-socket connection this screwing together has the advantage that a mechanically robust connection can be established. Further, a small required construction space becomes possible. Still further, it becomes possible to use printed circuit boards and automated component placement and soldering so that an efficient manufacturing is enabled. The screw can be a screw that allows for manual operation without a screw driver to make an efficient reconfiguration of the detection assemblies possible. The connectors are mechanically robust in a connected state and in an unconnected state.

[0036] In an embodiment of the floor cable channel the calculation units in every second detection assembly are connected via cables so that two independently connected chains are formed. The multiple detection assemblies preferably include at least four detection assemblies. By only connecting the calculation units in every second detection assembly it becomes possible that two independently connected chains are formed in a single line of detection elements. In case one of the two independently connected chains is damaged and/or fails for another reason, the other may still operable. If, in this case, only every second detection assembly can still read out passing sports timing transponders, this may result in a reduced detection rate. However, it is likely that also in this case at least a good part of the passing sports timing transponders can be detected. Consequently, the robustness of the race timing system is increased. Usually, at least four detection assemblies are connected to one another so that a start, finish or intermediate timing position can be spanned.

[0037] In an embodiment of the floor cable channel a connection portion of a first channel element is designed for being connected to a connection portion of a second channel element by means of a connection element allowing a rotational movement of the first channel element relative to the second channel element about a rotational axis orthogonal to a first longitudinal axis of the first channel element and orthogonal to a second longitudinal axis of the second channel element. By means of said rotational movement, the floor cable channel is brought into a transport position in which the channel elements are parallel to each other and into an operating position in which the channel elements are arranged one behind the other along their longitudinal axis. The connection element thereby connects two neighboring channel elements so that a folding mechanism is provided. This folding mechanism allows that the different channel elements, i.e. the different

detection assemblies, can be transported in a connected state so that no separate connection is needed upon deployment. This enables a fast and efficient set-up since the floor cable channel only has to be unfolded at the desired location. Furthermore, an erroneous set-up due to lack of experience of the personnel on site can be avoided. An efficient transport and set-up become possible.
[0038] In an embodiment of the race timing system, the race timing system includes a further decoder connected to a calculation unit of the last and/or last-but-one detection assembly. In case a single chain is formed, it is sufficient to connect the decoder to the last detection assembly. However, if two independently connected chains are formed as outlined above, the decoder is usually connected to the last and last-but-one detection assemblies. The further decoder thereby relates to an additional decoder in addition to the first decoder. This set-up thereby provides a further redundancy in case of failure of one of the decoders or in case of a defect that impedes communication through a certain position in the floor cable channel. Redundancy and reconfigurability are further improved.
[0039] Herein, the term circuitry can refer to a hardware implementation by means of different individual electronic components, such as resistors, transistors, capacitors, inductors and dials. It is, however, also possible that the term circuitry refers to a function implemented in a microcontroller. This implementation can thereby be based on soft- and/or hardware. All combinations are possible, for instance, a portion of the circuitry being implemented in hardware and another portion being implemented in the form of software running on a microcontroller. In particular, it is possible that the calculation unit is implemented in the form of a microcontroller that also, at least partly, carries out further functions. An external force or an environmental impact can be a mechanical impact, for instance from a runner stepping onto the channel element or a vessel passing over the channel element. An external force or an environmental impact can also be a weather condition, such as rain, cold/hot temperatures, dust etc.
[0040] Herein, a sports timing transponder particularly refers to a passive RFID tag that has no integrated energy source but is activated to send out its identity by an RFID reader. However, in certain embodiments, a sports timing transponder may also correspond to an active RFID tag. A sports event is particularly a running event such as a marathon or the like. However, a sports event can also be a bike race, a car race, a ski race, a horse race, a swimming competition etc. An identity of a sports timing transponder can particularly be an alphanumeric number of the RFID tag. This alphanumeric identifier is programmed to the transponder upon manufacturing. The determination of a passing time may include activating and reading the identity of the sports timing transponder multiple times. The time of the strongest read could then, e.g., be considered to represent the passing time (passing time detection based on received signal strength). As used herein, the term decoder refers to a piece of hardware that is used at a sports event to determine passing times of passing sports timing transponders. A decoder does not necessarily decode any signal. In particular, a decoder does not necessarily include an RFID reader. The term center protection area does not mean that the corresponding area is necessarily arranged in the geometrical center. An offset is possible.

Description

[0041] These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter. In the following drawings
[0042] FIG. **1** shows a schematic illustration of participants of a sports event having a passing time measured by a race timing system according to an aspect of the present invention;
[0043] FIG. **2** shows a schematic perspective illustration of a decoder for a race timing system according to an aspect of the present invention with a protective flap in a closed state;

[0044] FIG. **3** shows a schematic perspective illustration of the decoder with the protective flap in an open state;
[0045] FIG. **4** shows a schematic perspective illustration of a reader interface of the decoder;
[0046] FIG. **5** shows a schematic illustration of a cable connection interface of the decoder arranged under the protective flap;
[0047] FIG. **6** shows a schematic illustration of a brush extension of the decoder;
[0048] FIG. **7** shows a schematic side view illustration of the decoder;
[0049] FIG. **8** shows a schematic illustration of different mandatory and optional components of the decoder;
[0050] FIG. **9** shows a schematic illustration of a floor cable channel according to an aspect of the present invention;
[0051] FIG. **10** shows a schematic illustration of multiple detection assemblies being connected in a daisy chain;
[0052] FIG. **11** shows a schematic illustration of an alternative connection of the multiple detection assemblies in a daisy chain;
[0053] FIG. **12** shows a schematic illustration of the different components of a calculation unit in a detection assembly of the present invention;
[0054] FIG. **13** shows a schematic illustration of a floor cable channel of the present invention being brought from an operating position (a) via an intermediate position (b) into a transport position (c);
[0055] FIG. **14** shows a schematic illustration of a race timing system including two decoders connected to two sides of a floor cable channel;
[0056] FIG. **15** shows a schematic illustration of a detection assembly according to an aspect of the present invention;
[0057] FIG. **16** shows a schematic illustration of a channel element according to an aspect of the present invention;
[0058] FIG. **17** shows a schematic illustration of a channel element including an antenna as well as a first cable, a second cable and a cable in a bypass protection area;
[0059] FIG. **18** shows a schematic illustration of a sectional view of a channel element;
[0060] FIG. **19** shows a schematic illustration of four channel elements;
[0061] FIG. **20** shows a schematic illustration of four detection assemblies;
[0062] FIG. **21** shows a schematic illustration of another embodiment of a floor cable channel including four detection assemblies;
[0063] FIG. **22** shows a schematic illustration of a channel element;
[0064] FIG. **23** shows a schematic illustration of an assembly of a calculation unit and an antenna including a first connector part for connecting to a cable;
[0065] FIG. **24** shows a schematic illustration of a second connector part located at a cable; and
[0066] FIG. **25** shows a schematic illustration of first connector part being in connection with a second connector part to establish an electric connection.
[0067] In FIG. **1** a plurality of participants participating in a sports event is schematically illustrated. The participants **10** may particularly be runners in a running event such as a marathon or the like. A participant **10** is identified by means of a bib number **12** corresponding to a participant ID. The bib number **12** can, e.g., be attached to the participant's shirt, to a handle bar of a bike or to a chassis of a race car. In the illustrated example, the bib number **12** has attached thereto a passive RFID sports timing transponder **14**. This sports timing transponder **14** is used for carrying out a measurement of a passing time and for determining the identity via RFID when the participant **10** crosses the start or finish line or passes a split time measuring point.
[0068] In order to carry out the measurement of the passing time, the present invention proposes to make use of a race timing system **16** that includes a decoder **18** and a floor cable channel **20** that comprises multiple channel elements **22**. In at least some of the channel elements **22** an antenna is

arranged for reading out the passing sports timing transponders **14** in order to determine their passing times. Herein, a channel element **22** with an antenna and a calculation antenna arranged therein is referred to as a detection assembly.

[0069] FIGS. **2** to **7** show different views of an embodiment of a decoder **18** according to an aspect of the present invention. In FIGS. **2** to **7** but also in all other figures, corresponding reference numerals refer to the same components, respectively. However, not all reference numerals are inserted in all figures for the benefit of a clearer representation. For the same reason it is sometimes refrained from inserting the same reference numerals multiple times in a single figure to designate several similar components.

[0070] The decoder **18** in FIGS. **2** to **7** includes a reader interface **24**, a cable connection interface **26**, a user interface **28**, a housing **30** and a processing unit that is arranged within the housing **30**.

[0071] According to the invention, the user interface **28** is arranged on an outside of the housing **30**. In the illustrated example, the user interface **28** includes a display **32** via which configuration feedback is provided to a user in addition to multiple buttons **34** that allow for the user to interact with the decoder **18** and, e.g., provide configuration information. Particularly, the user can obtain information on a status of the decoder **18** and the current readouts via the user interface **28**. For instance, passing times of sports timing transponders or also IDs of passing sports timing transponders can be displayed.

[0072] In the illustrated exemplary embodiment, the user interface **28** is arranged on a top side of the housing **30** facing upwards when the decoder **18** is put on a ground surface. The user interface **28** is resistant to rain or splash water and/or resistant against further environmental impacts such as direct sunlight or mechanical stress etc., thereby allowing an operation in outdoor applications. Preferably, the display **32** can be implemented in the form of a monochrome LCD display that can be read out during daylight, if illuminated by the sun. It is possible that the display **32** is additionally equipped with a multicolor screen backlighting and can thus be illuminated in different colors. Via this additional information it becomes possible to efficiently inform a user of configuration parameters such as, for example, information about a timing position to which the decoder **18** is currently assigned.

[0073] The cable connection interface **26** particularly includes a network cable connector and/or a computer interface cable. In the illustrated example, the cable connection interface **26** includes three different network cable connectors **36** (network sockets), a regular USB connector **38** as well as a USB-C connector **40**. The USB connector **38** and the USB-C connector **40** are configured for connecting a computer interface cable corresponding to a USB cable. The cable connection interface **26** may include further interfaces such as a power interface **41** for connecting a power cable and others.

[0074] In order to protect the connectors from environmental impacts, in particular splash water, the cable connection interface **26** is arranged under a protective flap **42**. Thereby FIGS. **2**, **4**, **6** and **7** illustrate a closed state of the protective flap **42** whereas FIGS. **3** and **5** illustrate an open state of the protective flap **42** in which the cable connection interface **26** can be accessed.

[0075] The protective flap **42** is preferably arranged to cover an upper portion of a front side of the housing **30**. Thereby, the front side corresponds to a side of the housing **30** that is essentially oriented in a 90° angle to the top side of the housing and faces in the direction of the user when the user reads the display **32**. As illustrated in FIGS. **3** and **5**, the protective flap **42** can be opened to allow access to the cable connection interface **26**. When the protective flap **42** is flapped open, cables can be connected and disconnected.

[0076] In the illustrated embodiment the protective flap **42** is hinged pivotably about a pivot axis **44** that is substantially parallel to the top side of the housing and the front side of the housing. As illustrated, the pivot axis **44** is positioned in a top side plane of the housing **30**.

[0077] As it can be seen in FIGS. **2** and **3**, the protective flap **42** may particularly have a curved shape that, in the illustrated embodiment, spans an angle of 90°. In order to lock the protective flap

42 in place, the illustrated embodiment of the decoder **18** includes a housing **30** having a locking mechanism **46**. This locking mechanism **46** comprises at least one magnet **48** for magnetically holding the protective flap **42** in the closed state. In the illustrated embodiment, two magnets **48** are positioned in a portion of the housing **30** that is covered by the protective flap **42** in a closed state. The magnets **48** interact with corresponding counterparts **50**, in particular magnets or metal plates that are integrated in the protective flap **42**. When the protective flap **42** is closed, it is kept in place by the magnets **48** interacting with the counterparts **50**. It is to be understood that the positions of the magnets and the counterparts can thereby also be switched.

[0078] In the illustrated embodiment, the protective flap **42** includes a lower portion **52** that, in a closed state, covers a section of the housing **30** below the cable connection interface **26**. This makes it possible that rain or splash water that impacts the decoder **18** cannot reach the cable connection interface **26** and the connectors arranged therein in spite of capillary effects.

[0079] Further, in the illustrated embodiment, the housing **30** includes a brush extension **54** that reaches to the lower portion **52** of the protective flap **42** in the closed state. The brush extension **54** thereby corresponds particularly to a brush that allows cables to pass through the bristles but blocks splash water and water running along a cable from entering into the cable connection interface **26**. The bristles of the brush extension **54** further improve the resilience against environmental impacts by providing an additional barrier.

[0080] In the illustrated embodiment, the reader interface **24** is arranged on a back side of the housing **30** and includes a passive RFID connector **58** as well as a loop antenna connector **60**.

[0081] The passive RFID connector **58** connects to one or more RFID reader circuitries which again have an antenna connected. The passive RFID connector **58** is configured to receive detections of passive RFID sports timing transponders. In particular, the passive RFID connector **58** can be configured for connecting thereto a floor cable channel including multiple detection assemblies, each having an antenna and circuitry for detecting RFID tags.

[0082] The loop antenna connector **60** is configured to connect to an induction loop for communicating with active sports timing transponders. In particular, an electric field can be induced that can then be detected by active RFID sports timing transponders. The active RFID sports timing transponders can themselves calculate a passing time and transmit their passing time, for instance, via a wireless connection and a wireless communication antenna **62** of the decoder **18**.

[0083] In the illustrated embodiment, the decoder **18** includes a top connection portion **64** that is arranged in the area of the top side of the housing **30** and a matching bottom connection portion **66** that is arranged in the area of a bottom side of the housing **30**. The top connection portion **64** and the bottom connection portion **66** work together to provide for a stackability of multiple decoders **18**. Thereby, it is possible that the top connection portion **64** provides two recesses on the top side of the housing **30** into which two or four protrusions on the bottom side of the housing **30** forming the bottom connection portion **66** can extend. The stackability thereby provides for a better storability of multiple decoders **18**. Multiple decoders **18** can be stacked one over the next.

[0084] In the illustrated embodiment the housing **30** includes a recess **68** in the area of the bottom side of the housing **30** that provides a space for opening and closing the protective flap **42** of a below-stacked further decoder. Thus, if multiple decoders are stacked one over another, it is still possible to open their protective flaps **42** since, in the open state, the protective flap **42** can extend into the recess **68** of the above-stacked decoder **18**. This results in an accessibility of the cable connection interface **26** of all decoders in a stack of decoders.

[0085] Still further, the decoder **18** in the illustrated embodiment includes two battery compartments **70** that are configured to house two batteries. A battery fixation mechanism **76** makes it possible that batteries are housed and fixated in the battery compartments. For this, the battery fixation mechanism **76** includes two further protective flaps **72** and a closing element **78**. The battery compartments can be closed by means of the two further protective flaps **72**. The further protective flaps **72** can, e.g., pivot about two pivot axes **74**, as illustrated in FIG. **6**, to allow access to the batteries. The closing element **78** allows for fixating the two protective flaps **72** in a closed position.

[0086] Thereby, the closing element **78** is configured to simultaneously close both further protective flaps **72** in a first position and to selectively close only one of the further protective flaps **72** while opening the other of the further protective flaps **72** in a second and third position. In the illustrated embodiment, the closing element **78** is implemented in the form of a pivotable and irregularly shaped element that mechanically fixates both or one of the two further protective flaps **72**. The pivot axis of the closing element **78** is thereby perpendicular to the illustrated plane of projection in FIGS. **5** and **6**. Preferably, it is possible that the closing element **78** is held in one of the first, second and third position by means of a spring or another locking mechanism. The closing mechanism **78** makes it possible that one battery is replaced while the other battery remains fixated in the battery compartment **70**. Thus, power supply can be maintained while changing one of the batteries. The two further protective flaps **72** are preferably transparent to allow a user to visually assess a presence and/or a charging state indication of a battery in a battery compartment **70**. It is also possible that the charging state of the batteries assessed while the decoder itself is not operated and/or in a low-power mode. In combination with the stackability as described above, the transparency makes it possible that a presence and/or charging state of the batteries is assessed also while multiple decoders are stacked one over the other.

[0087] The decoder **18** may further include a bumper element **80**. In the illustrated embodiment, the bumper element **80** comprises two rubber elements that embrace the housing **30** on a left and right side. The bumper element **80** thereby increases a resistance of the decoder **18** against mechanical stress during storage or during operation at a site of a sports event. As illustrated in the profile view in FIG. **7**, the bumper element **80** thereby has a protrusion **82** on the back side of the housing **30** opposite to the side of the protective flap **42**. In the illustrated embodiment this protrusion **82** is formed so that the decoder **18** tips over when being placed on the protrusion **82**. The protrusion **82** corresponds to a rounded portion of the bumper element **80**. In other words, the shape of the bumper element **80** is irregular so that the decoder cannot securely stand on the ground when the protrusion **82** faces downwards. This makes it impossible to place the decoder **18** in a position in which the protective flap **42** and the below-arranged cable connection interface **26** face upwards. Thus, even if a user tries to place the decoder **18** with the cable connection interface **26** facing upwards in the direction of pouring rain, this is not possible.

[0088] FIG. **8** schematically illustrates the decoder **18** and its various components. Therein, dashed lines indicate optional components. The decoder **18** includes a reader interface **24**, a cable connection interface **26**, a user interface **28**, a processing unit **84**, a housing **30** and a protective flap **42**.

[0089] Optionally, the decoder **18** includes a ventilation unit **86** for ventilating an inside of the housing **30** with outside air. In the illustrated embodiment, a ventilation outlet **45** and a ventilation inlet **47** are arranged under the protective flap **42** so that they are protected from environmental impacts, in particular splash water and rain. Air can enter and exit from the space under the protective flap **42** in the closed state through corresponding openings, e.g. underneath the lower portion **53** of the protective flap **42**.

[0090] As further illustrated, it is possible that the protective flap **42** includes a barrier protrusion **43** that forms an airflow barrier between the ventilation outlet **45** and the ventilation inlet **47** under the protective flap in the closed state and blocks air from directly flowing between the inlet and the outlet. In the illustrated example the barrier protrusion **43** corresponds with a lower protrusion **49** arranged in the space under the protective flap **42** in the closed state. However, other mechanical implementations are possible in this respect.

[0091] Particularly, this barrier protrusion **43** can include an opening for a plug of a power cable. When a power cable is plugged in the opening is closed and the airflow between the inlet and the outlet is blocked while charging batteries or performing other power consuming operations that

require ventilation.
[0092] It is possible that the ventilation unit **86** is thereby controlled based on a reading of a temperature sensor **88** and a humidity sensor **90** that are arranged within the housing **30**. The ventilation strength of the ventilation unit **86** is thereby adjusted to prevent water condensation in the inside of the housing that might cause harm to the electronic components included in the housing **30**. The combination of a temperature sensor **88** with a humidity sensor **90** has the advantage that water condensation in the housing can be prevented also in situations where it is cold outside.
[0093] Further optionally, the decoder **18** can include an RFID chip **92** for carrying information on the decoder **18**. In particular, the RFID chip **92** is programmable via the processing unit **84**. This makes it possible that even if the processing unit **84** is not operating or switched on (e.g. in order to save energy), information on the decoder **18** can be obtained by reading out the RFID chip **92** with a corresponding reader. For instance, if multiple decoders **18** are stored, an inventory control is facilitated. By programming the RFID chip **92** with the processing unit **84** it is possible to further write information on the RFID chip **92**. For instance, the recharging state of a battery can be provided as further information to be read out. Energy can be saved since a readout is possible if the decoder **18** and processing unit **84** are not powered at all or run at a very low power consumption.
[0094] Further, it is possible that the decoder **18** includes an active RFID reader processing circuit **94** for determining passing time of active sports timing transponders. This active RFID reader processing circuit **94** can particularly interact with an induction loop connected to the loop antenna connector. The active RFID sports timing transponders may wirelessly transmit information to a wireless communication antenna of the decoder.
[0095] Still further, the decoder **18** may include a heating unit **96** for heating at least one battery in one of the battery compartments. This heating unit may particularly include an aluminum board that is arranged close to the batteries (in particular over the batteries) in the battery compartments. By heating the batteries or warming the batteries it becomes possible to operate the decoder **18** also in cold environments (in particular to enable charging the batteries in cold environments) and increase runtime and lifetime of the batteries.
[0096] Still further, the decoder **18** may include a communication unit **98** for communicating via a mobile communication network. In particular, it is advantageous if the communication unit **98** has a first SIM module for receiving a first physical or virtual SIM card and a second SIM module for receiving a second physical or virtual SIM card. By making use of two SIM cards, it becomes possible that one SIM card is accessed by the user whereas the other SIM card is arranged internally and cannot be accessed by the user. Thus, it is possible that a user inserts his own SIM card and communicates via his wireless network of choice, whereas another SIM card is provided by a service provider and assures that the service provider can access the decoder **18** for providing software updates etc. independently of the user's own SIM card and mobile network connection.
[0097] The processing unit **84** is configured to control the different components. Furthermore, the processing unit **84** may process data received via the reader interface **24** and communicate the processed data to the internet. The processing unit **84** may also control components, in particular detection assemblies connected via the reader interface **24**, e.g. by providing a synchronization signal or configuration parameters. The processing unit **84** may particularly be implemented in the form of a microcontroller or system-on-chip (SoC) running a corresponding software.
[0098] FIG. **9** shows a schematic illustration of the race timing system **16** according to an aspect of the present invention. The race timing system **16** includes a decoder **18** in addition to a floor cable channel **20** having six channel elements **22**, each including an antenna and a calculation unit to form a detection assembly **102**. The cable channel **20** is connected to the decoder **18** via a cable **100** connecting a calculation unit in a detection assembly **102** to the reader interface of the decoder **18**.

[0099] The floor cable channel **20** includes multiple detection assemblies **102**, each comprising an antenna and a calculation unit housed in a channel element **22**. The channel element **22** thereby corresponds to a mechanical protection of the antenna and the calculation unit connected to the antenna to protect the antenna and calculation unit from external forces such as vessels passing over the floor cable channel **20**, weather conditions like snow or rain, or participants of a running event etc. The multiple detection assemblies **102** thereby form a line. The number of detection assemblies **102** in a line or in a floor cable channel **20** is thereby flexible. For instance, six detection assemblies **102** can be connected.
[0100] FIGS. **10** and **11** illustrate different options for the wiring of the multiple detection assemblies **102** of a floor cable channel **20**. Each detection assembly **102** includes a channel element **22**, a calculation unit **104** and an antenna **106**. Each channel element **22** is connected to a preceding channel element **108** and a following channel element **110**. It is to be understood that the following and the foregoing description is thereby outlined from the point of view of the detection assembly **102** in the middle of the illustrated floor cable channel **20** but that the concept is applicable to all the different detection assemblies **102**.
[0101] As illustrated in FIG. **10**, the calculation unit **104** can be connected to a first neighboring calculation unit **112** via a first cable **114** and to a second neighboring calculation unit **116** via a second cable **118**. Thereby, the first cable **114** extends into the preceding channel element **108** and the second cable **118** extends into the following channel element **110**.
[0102] FIG. **11** shows an alternative configuration. The calculation unit **104** is connected via the first cable **114** to a first neighboring calculation unit **112** located in a pre-preceding channel element **120**. Thereby, the pre-preceding channel element **120** corresponds to the channel element preceding the preceding channel element **108**. Similarly, the calculation unit **104** is connected to a second neighboring calculation unit **116** located in a post-following channel element **122**. In other words, every second calculation unit **104** in the floor cable channel **20** is connected so that essentially two chains of communication are formed. The cables are bypassed through the preceding channel element and the following channel element, respectively. By making use of two chains of communication it becomes possible to improve resilience against mechanical defects. For instance, if one line of communication is damaged, there still exists another line of communication so that at least part of the detections can still be made. For better legibility, FIG. **11** does not show the connection between each calculation unit **104** and antenna **106** in the channel elements.
[0103] FIG. **12** schematically illustrates a calculation unit **104** of a detection assembly. The calculation unit **104** includes a voltage detection circuitry **124**. Optionally, the calculation unit **104** includes a data bus circuitry **126**, a terminal detection circuitry **128**, a position detection circuitry **130**, a reconfiguration circuitry **132**, a communication circuitry **134**, a defect detection circuitry **136** and an RFID reader circuitry **138**. Thereby, the different components (circuitries) can be partly or completely implemented in soft- and/or hardware. It is possible that one component fulfills the functionalities of multiple of the circuitries. In particular, the calculation unit **104** can correspond to a microcontroller having multiple peripheral and other electronic components connected thereto. The calculation unit can also be referred to as a reader unit or as an RFID reader.
[0104] The voltage detection circuitry **124** is configured to detect whether power is provided to the calculation unit **104** via the first cable or via the second cable. In particular, this makes it possible to determine via which of the two cables the calculation unit **104** is connected to a decoder providing the power supply and receiving the determined information from the passing sports timing transponders. It is thereby possible that the voltage detection circuitry **124** includes a metal oxide semi-conductor field-affect transistor that enables a through-switching of electrical power from one calculation unit to the next in the chain. Alternatively, it is possible that a bipolar junction transistor (BJT), a relay or another switch is used. Upon start-up of the detection assembly, i.e. upon initial power connection, the voltage detection circuitry **124** determines from which side power is provided. Then, a through-connection is initialized so that power is connected through to

the respective neighboring calculation unit. During operation and in case power is lost (new set-up, reconnection, reconfiguration etc.) a corresponding memory portion is deleted and it is detected from which of the first cable and second cable power is provided anew.

[0105] The data bus circuitry **126** may provide a data bus communication with further calculation units of further detection assemblies connected via the first cable and the second cable in a daisy chain. A data bus communication thereby refers particularly to serial bus communication that provides a communication with or without a host device. In particular, it is possible that the data bus circuitry **126** provides a CAN bus communication. Alternatively, another bus system can be used, in particular a differential bus system such as RS-485. Also, Powernet can be used. The different calculation units connected to one another in a chain may communicate with a processing unit positioned in a decoder connected to the floor cable channel. A serial communication is established.

[0106] The terminal detection circuitry **128** allows detecting whether the calculation unit **104** is connected to only one of the first neighboring calculation unit and the second neighboring calculation unit. For instance, a resistor may be switched to terminate the data bus if no further calculation unit is connected. Upon initial start-up the default operation is preferably that each of the calculation units in the chain terminates the data bus communication. If power is connected to the first calculation unit in the chain, it is checked whether a neighboring calculation unit acts on one of the data pins of the bus communication. Only if this is the case, the data bus is connected through to the respective neighboring calculation unit. This allows for assuring that the data bus communication can be established. In order to detect defects in the data bus communication, a time-out functionality can be implemented. If a predetermined time passes after no data bus communication is possible, then the terminal detection circuitry **128** again terminates the data bus communication and only reestablishes the communication upon determining that the respective neighboring calculation unit acts on one of the data pins. This makes a reconfiguration during runtime possible.

[0107] The position detection circuitry **130** makes it possible to detect a number of calculation units connected via the first cable and/or a number of calculation units connected via the second cable. Thereby, the position detection circuitry **130** can announce its presence on the data bus upon start-up. In a centralized communication scheme with a central host or master, it can then be attributed a number corresponding to its position in the chain from this master. Alternatively, it is also possible that upon receipt of the start-up message from the new calculation unit in the chain, all other calculation units that are already present in the chain provide a reply message on the data bus so that the position detection circuitry can assess a number of calculation units already present and can attribute a next higher number to itself corresponding to its position in the chain. Other possible solutions include that only the other calculation unit with the currently highest ID replies.

[0108] The reconfiguration circuitry **132** allows for detecting a change in a number of calculation units connected via the first cable and/or a change in a number of calculation units connected via the second cable. This again allows for detecting a defect of one of the calculation units in the chain during runtime or a reconfiguration of the floor cable channel during runtime.

[0109] The communication circuitry **134** may particularly be suitable for communicating with a decoder and a processing unit of this decoder that is connected via the first cable or via the second cable. The communication circuitry **134** can thereby provide for a data bus communication, preferably a CAN-bus communication. It is possible that the communication circuitry **134** is configured to receive from the decoder a synchronization signal for synchronizing operation of the calculation units in the line of detection assemblies or in the chain of calculation units, respectively. Further, it is possible that a position information is received from the decoder indicating a position of the calculation unit in a chain of calculation units from the point of view of the decoder. This position information may form the basis for an efficient bus communication.

[0110] The defect detection circuitry **136** provides for detecting defects in the calculation unit. In particular, the defect detection circuitry **136** may be implemented in the form of a separate integrated circuit. This makes it possible that even if a central microcontroller of the calculation unit **104** is defect, it is still possible to connect the two neighboring calculation units with one another. Thereby, this connection particularly includes a data communication and a power connection. This defect detection circuitry **136** makes it possible that an additional safety against hardware failures is obtained. As soon as a defect is detected, the respective calculation unit is skipped so that at least part of the functionality of the cable channel can be maintained.

[0111] The RFID reader circuitry **138** may particularly correspond to the circuitry necessary for detecting a passing RFID transponder. In particular, the calculation unit may thereby correspond to an RFID reader. The signals obtained via the antenna are evaluated to determine whether a passive RFID-tag corresponding to the sports timing transponder has passed. If one passing passive RFID-tag is detected, a corresponding passing time is determined. In particular, it is still thereby possible that a received signal strength (RSS) is evaluated. Alternatively/additionally, however, it is possible that a phase change of a signal is evaluated.

[0112] In FIG. **13** an embodiment of a floor cable channel **20** of the present invention is schematically illustrated. The illustrated floor cable channel **20** includes six detection assemblies **102** that are connected to one another to form a line. In FIG. **13** (*a*) the floor cable channel **20** is in an operating position in which the different channel elements **22** are arranged one behind the other along their longitudinal axis. FIG. **13** (*b*) schematically illustrates that by means of a rotational movement of the neighboring channel elements **22** versus one another in the direction of the illustrated arrows the floor cable channel **20** can be brought into a transport position, as illustrated in FIG. **13** (*c*). One of the rotational axes **140** is schematically illustrated in FIG. **13** (*b*). In the transport position illustrated in FIG. **13** (*c*) the channel elements **22** of the floor cable channel **20** are arranged parallel to each other.

[0113] By bringing the floor cable channel **20** from the transport position into the operating position an easy set-up of the race timing system of the present invention becomes possible. For instance, if multiple floor cable channels **20** have to be installed on site at a sports event, the set-up is facilitated by making it possible that the different floor cable channels **20** are transported to their respective positions in the transport position and deployed by means of the illustrated rotational movement.

[0114] In order to provide this rotation functionality, the different channel elements **22** of the floor cable channel **20** are connected to their neighboring channel elements by means of connection elements **142**. These connection elements **142** can be joint-like. For instance, a hook or double hook representing a connection element **142** can be clamped into corresponding receptacles in neighboring channel elements **22**.

[0115] In FIG. **14** another embodiment of a race timing system **16** of the present invention is schematically illustrated. The race timing system **16** includes a floor cable channel **20** that is connected to a decoder **18** and a further decoder **144**. The two decoders **18**, **144** are arranged on two different sides of the floor cable channel **20**. On the one hand, such a set-up can provide for redundancy if one of the two decoders **18**, **144** fails. On the other hand, it is also possible that two separate chains of calculation units as illustrated in FIG. **11** are independently connected to separate decoders **18**, **144**.

[0116] In FIGS. **15** to **17** an embodiment of a detection assembly **102** including a channel element **22**, an antenna **106** and a calculation unit **104** is illustrated. The channel element **22** includes a top portion **150** and a bottom portion **152** connectable to the top portion **150**. FIG. **15** illustrates the detection assembly **102** with the top portion **150** covering the bottom portion **152** in which the antenna **106** and the calculation unit **104** are housed. FIG. **16** shows the bottom portion **152** of the channel element **22** without the antenna **106**, the calculation unit **104** and the connecting cables. FIG. **17** shows the bottom portion **152** with the antenna **106**, the calculation unit **104** and the corresponding cables therein.

[0117] The connection between the top portion **150** and the bottom portion **152** can be implemented in the form of a snapping or clicking mechanism.

[0118] The antenna **106** and the calculation unit **104** may be arranged on two printed circuit boards being stacked with a spacer layer between. Thereby, the spacer layer can particularly be implemented in the form of a polystyrene layer. The antenna **106** can particularly be implemented in the form of a patch antenna. By making use of the polystyrene layer in between the calculation unit **104** and the antenna **106** it becomes possible to obtain a suitable directional characteristic of the antenna **106** in the desired direction (in particular upward when the detection assembly is placed on the ground in order to detect sports timing transponders of participants in a sports event).

[0119] Referring to FIGS. **15** to **17** the channel element **22** includes a first connection portion **154** for connecting the channel element **22** to a preceding channel element and a second connection portion **156** for connecting the channel element **22** to a following channel element. As illustrated and as also explained above, the connection can thereby, e.g., be implemented in the form of one or multiple connection elements **142** that are designed to clamp to corresponding protrusions **158**.

[0120] The channel element **22** includes a center protection area **160** in which the antenna **106** is received. Further, the channel element **22** includes a first protection area **162** for receiving a first cable **114** and a second protection area **166** for receiving a second cable **118**. Thereby, the first protection area **162** connects the center protection area **160** to the first connection portion **154**, i.e. the connection portion connecting the channel element to a preceding channel element.

[0121] Thus, a cable can be guided from the center protection area **160** to the first connection portion **154**. The second protection area **166** connects the center protection area **160** to the second connection portion **156**. In addition, the channel element **22** includes a bypass protection area **170** that connects the first connection portion **154** to the second connection portion **156**. In this respect the term connect means that respective protection area is designed to house and protect a respective connection cable.

[0122] In the illustrated embodiment, the center protection area **160**, the first protection area **162** and the second protection area **166** correspond to cavities formed between the top portion **150** and the bottom portion **152**. In particular, the cavities are formed out in the bottom portion **152** and are covered by flat segments of the top portion **150**.

[0123] The channel element **22** of the present invention thereby makes it possible that in a line of multiple channel elements that are connected at their respective connection portions, the calculation units in every second channel element are connected to one another (for data and power transfer). Thus, the second cable **118** of one detection assembly connects the calculation unit of this detection assembly to a calculation unit in a channel element that follows the following channel element. The second cable **118** is thereby guided through the bypass protection area **170** of the following channel element.

[0124] FIG. **18** schematically illustrates a sectional view of a channel element of the present invention. As illustrated, the top portion **150** overlaps the bottom portion **152** in a direction orthogonal to a longitudinal axis of the channel element (right-left-direction in FIG. **18**). In the illustrated embodiment, the overlap thereby corresponds to flexible protrusion portions **172** on both sides of the top portion **150**. These flexible protrusion portions **172** are designed to accommodate unevenness of the underlying surface. The flexible protrusion portions **172** thereby extend along the longitudinal axis of the channel element so that over the entire length of the channel element the top portion can provide for a direct contact of the channel element **22** with the underlying surface.

[0125] In FIG. **19** an embodiment of a floor cable channel **20** comprising four detection assemblies and four channel elements is illustrated. The following description and explanation is to be understood from the perspective of the second channel element **22** or detection assembly **102** from the left side but can be transferred to others in the line and to longer/shorter floor cable channels.

[0126] The channel element **22** is connected at its first connection portion **154** to a preceding channel element **108** and, at its second connection portion **156**, to a following channel element **110**. In the illustrated embodiment, the preceding first connection portion **154***a* of the preceding channel element **108** is connected to the first connection portion **154** of the channel element **22**. The following second connection portion **156***b* is connected to the second connection portion **156** of the channel element **22**. The first cable **114** runs from the first protection area **162** to the preceding bypass protection area **170***a* of the preceding channel element **108**. The second cable **118** in the second protection area **166** is guided to the following bypass protection area **170***b* in the following channel element **110**. Consequently and as explained above, the calculation units in every second detection assembly are connected. In the illustrated example, the calculation unit in the preceding channel element **108** is connected to the calculation unit in the following channel element **110** by means of a cable running through the bypass protection area **170** of the channel element **22**.

[0127] As illustrated in FIG. **19**, the cable outlets of the first protection area **162** and the bypass protection area **170** at the first connection portion **154** are (optionally) arranged at a different distance from one another than the cable outlets of the second protection area **166** and the bypass protection area **170** at the second connection portion **156**. Thereby, the first connection portion **154** can only be connected to a preceding first connection portion **154***a* of the preceding channel element **108**. This construction makes it possible to avoid a crossing of the cables, which again results in an additional increase in robustness.

[0128] As illustrated in FIGS. **20** and **21**, it is thereby possible that either both chains of calculation units are connected on one side of the cable channel (left side in FIG. **20**) or that the different chains are connected on two sides of the floor cable channel **20** (FIG. **21**).

[0129] In FIG. **22** the bottom portion **152** of a channel element **22** is schematically illustrated. In the example, the bypass protection area **170** is designed to include a relay portion **174** in addition to a terminal portion **176**. Thereby, the relay portion **174** is designed to connect the first connection portion **154** to the second connection portion **156**, i.e. to guide a cable through the entire channel element **22** between two corresponding cable outlets. On the other hand, the terminal portion **176** is designed to store an end section of a cable in the bypass protection area **170**. A cable in the bypass protection area can alternatively be placed in the terminal portion **176** or in the relay portion **174**. Thus, an overlap of the cable can be prevented in case the channel element **22** represents the last channel element in a floor cable channel. In the bypass protection area **170** a cable originating from a preceding channel element can be housed and protected from environmental impacts. In order to prevent an overlap of this cable out of the channel element **22**, the cable can be stored in the terminal portion **176** (by a user) if no further channel elements are to be connected.

[0130] In FIGS. **23**, **24** and **25** a preferred embodiment of a connection between a cable **114**, **118** (first cable or second cable, respectively) and a calculation unit **104** is schematically illustrated. The calculation unit **104** is connectable to the first cable **114** and/or the second cable **118** by means of a first connector part **178** and a second connector part **180** that are designed for being screwed together by means of a screw **182** to establish an electric connection (and a robust mechanical connection). In the illustrated embodiment, the electric connection has four conductors. It is, however, also possible to use different number of conductors. FIG. **23** particularly shows the first connector part **178**, FIG. **24** particularly shows the second connector part **180** and FIG. **25** particularly shows the two connector parts **178**, **180** being screwed together by means of the screw **182**.

[0131] In comparison to previous approaches relying on plug-and-socket connections the use of the screw **182** for connecting the first connector part **178** and the second connector part **180** allows for a robust connection that provides mechanical stability in a comparably small construction space. Further, an efficient manufacturing becomes possible. It is to be understood that the connection principle including the first connector part **178** and the second connector part **180** can also be used independently of the design of the channel element **22** as illustrated in the other figures and as described herein and/or in other application areas.

[0132] As illustrated, the antenna **106** and the calculation unit **104** can be integrated in an assembly and, e.g., be arranged on a common printed circuit board. For mechanical protection this assembly can be hosted within a casing or the like. The connection of the calculation unit **104** (and the antenna **106**) to the first cable **114** and/or the second cable **118** can be established via a first connector part **178** on the side of the calculation unit **104**. As illustrated, this first connector part **178** can include a printed circuit board **184**. In particular, this printed circuit board **184** can accommodate the calculation unit **104**. In the illustrated embodiment the first connector part **178** includes four pogo pins **188** for establishing the electric connection when the second connector part **180** is screwed to the first connector part **178**. The pogo pins **188** are spring-loaded pins for establishing an electric connection and providing a durable and resilient electric connection.
[0133] In the illustrated embodiment the second connector part **180** also includes a printed circuit board **186** having a hole **192** for the screw **182**. As illustrated, the screw is (optionally) fixed by means of a clip **194** to prevent a loss of the screw **182**, when the second connector part **180** is not in connection with the first connector part. The first connector part **178** can include a threaded connector **190** that is designed for receiving the screw **182**.
[0134] The two connector parts **178**, **180** are screwed together by means of a screw **182**. In the illustrated embodiment the screw is configured for manual operation by without a screw driver by means of a hinged clamp **196** attached to the screw **182**.
[0135] Between the two connector parts **178**, **180** a sealing (not illustrated) can be arranged to protect the actual conductors from moisture. It is possible to design at least one of the two connector parts **178**, **180** to hold this sealing in place, also while not being connected.
[0136] Herein, the different circuitries are in particular described with respect to their function. This functionality can be obtained by soft- and/or hardware. For instance, it is possible that the respective functionality is partly or completely implemented in a software running on a microcontroller. Thus, each calculation unit may include a microcontroller implementing the respective functions either alone or in communication and interaction with further passive or active electrical components such as resistors, capacitors and inductors.
[0137] The foregoing discussion discloses and describes merely exemplary embodiments of the present disclosure. As will be understood by those skilled in the art, the present disclosure may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. Accordingly, the description is intended to be illustrative, but not limiting the scope of the disclosure, as well as other claims. The disclosure, including any readily discernible variants of the teachings herein, defines, in part, the scope of the foregoing claim terminology such that no inventive subject-matter is dedicated to the public.
[0138] In the claims, the word “comprising” does not exclude other elements or steps, and the indefinite article “a” or “an” does not exclude a plurality. A single element or unit may fulfill the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.
[0139] The elements and units of the disclosed apparatuses, devices, circuitry and system may be implemented by corresponding hardware and/or software elements, for instance appropriated circuits. A circuit is a structural assemblage of electronic components including conventional circuit elements, integrated circuits including application-specific integrated circuits, standard integrated circuits, application-specific standard products, and field programmable gate arrays. Further a circuit includes central processing units, graphics processing units, and microprocessors which are programmed or configured according to software code. A circuit does not include pure software, although a circuit includes the above-described hardware executing software.

Claims

1-19. (canceled)

20. A detection assembly for detecting passing sports timing transponders in a sports event, comprising: an antenna and a calculation unit connected to the antenna; and a channel element for positioning the antenna and the calculation unit on an underlying surface and for protecting the antenna and the calculation unit from external forces, wherein said channel element is connectable to a preceding channel element and a following channel element to form a line; said calculation unit is connectable to a first neighboring calculation unit via a first cable extending into the preceding channel element and to a second neighboring calculation unit via a second cable extending into the following channel element; and said calculation unit includes a voltage detection circuitry for detecting whether power is provided to the calculation unit via the first cable or via the second cable, wherein the voltage detection circuitry is configured to determine from which one of the first cable or the second cable power is provided and to then initialize a through connection to provide power to the respective neighboring calculation unit.

21. The detection assembly as claimed in claim 20, wherein the calculation unit includes a data bus circuitry to provide a data bus communication with further calculation units of further detection assemblies connected via the first cable and via the second cable in a daisy chain.

22. The detection assembly as claimed in claim 20, wherein the calculation unit includes a terminal detection circuitry for detecting whether the calculation unit is connected to only one of the first neighboring calculation unit and the second neighboring calculation unit.

23. The detection assembly as claimed in claim 20, wherein the calculation unit includes a position detection circuitry for detecting a first number of calculation units connected via the first cable and/or a second number of calculation units connected via the second cable.

24. The detection assembly as claimed in claim 20, wherein the calculation unit includes a reconfiguration circuitry for detecting a change in a first number of calculation units connected via the first cable and/or a second number of calculation units connected via the second cable.

25. The detection assembly as claimed in claim 20, wherein the communication circuitry is configured to receive from the decoder a synchronization signal for synchronizing operation of the calculation units in the line; and/or to receive from the decoder a position information indicating a position of the calculation unit in a chain of calculation units from the point of view of the decoder.

26. The detection assembly as claimed in claim 20, wherein the calculation unit includes a defect detection circuitry for detecting a defect in the calculation unit and for establishing a direct connection between the first cable and the second cable.

27. The detection assembly as claimed in claim 20, wherein the calculation unit includes an RFID reader circuitry for detecting passing passive RFID tags in spatial vicinity of the antenna and determining a corresponding passing time.

28. The detection assembly as claimed in claim 20, wherein the channel element includes: a first connection portion for connecting the channel element to the preceding channel element and a second connection portion for connecting the channel element to the following channel element; a center protection area for receiving the antenna; a first protection area for receiving the first cable, wherein the first protection area is designed to connect the center protection area to the first connection portion, and a second protection area for receiving the second cable, wherein the second protection area is designed to connect the center protection area to the second connection portion; and a bypass protection area for receiving a cable, wherein the bypass protection area is designed to connect the first connection portion to the second connection portion.

29. The detection assembly as claimed in claim 20, wherein the calculation unit is connectable to the first cable and/or the second cable by means of a first connector part and a second connector part that are designed for being screwed together to establish an electric connection.

30. The detection assembly as claimed in claim 29, wherein the first connector part and the second connector part include printed circuit boards; and/or include at least one pogo pin for establishing the electric connection upon being screwed together.

31. The detection assembly as claimed in claim 29, wherein the first connector part includes a threaded connector for receiving a screw, in particular a soldered threaded connector.

32. The detection assembly as claimed in claim 30, wherein the first connector part and/or the second connector part are designed for holding a sealing in between for protecting the electric connection from moisture.

33. A floor cable channel comprising multiple detection assemblies according to claim 20 connected to one another to form a line.

34. The floor cable channel according to claim 33, wherein the calculation units in every second detection assembly are connected via cables so that two independently connected chains are formed.

35. The floor cable channel as claimed in claim 33, wherein a connection portion of a first channel element is designed for being connected to a connection portion of a second channel element by means of a connection element allowing a rotational movement of the first channel element relative to the second channel element about a rotational axis orthogonal to a first longitudinal axis of the first channel element and orthogonal to a second longitudinal axis of the second channel element; and by means of said rotational movement, the floor cable channel is brought into a transport position in which the channel elements are parallel to each other and into an operating position in which the channel elements are arranged one behind the other along their longitudinal axes.

36. A race timing system including a floor cable channel as claimed in claim 33 and a decoder connected to a calculation unit of the first and/or second detection assembly in the line, wherein the decoder is configured to synchronize operation of the connected detection assemblies.

37. The race timing system as claimed in claim 36, including a further decoder connected to a calculation unit of the last and/or last-but-one detection assembly.