

Electronic device

Description

The invention relates to an electronic device having particular security requirements which comprises a printed circuit board, wherein the printed circuit board is enclosed by a housing having two housing parts joined by means of a screw, wherein a separation of the housing parts automatically causes a change in state of the electronic device, wherein a first electrically conductive contact element contacts a first printed circuit board contact and is seated against the screw in the screwed-in state and wherein a second electrically conductive contact element contacts a second printed circuit board contact and is seated against the screw in the screwed-in state such that when the screw is screwed in an electrical connection exists between the two printed circuit board contacts.

Electronic devices are often subject to particular security requirements. They routinely have closed housings which prevent access to electronic components inside the device. In this situation, multi-part housings are for the most part screwed together in order to enable the housing to be opened for maintenance or repair work.

Suitable means are often employed in order to prevent the housing from being opened by a device user. If this happens however, the separation of the housing parts automatically causes a change in state of the electronic device. For example, an electronic switch which is in contact with one housing part is arranged on a printed circuit board. Releasing the housing part actuates the switch, which causes the device

to changes its state. Said change ranges for example from an electronic logging of the device tampering to a permanent functional restriction of the device.

An electronic device having two housing halves which enclose a printed circuit board and are held closed by means of a screw is known from US 2005/088303 A1. Each contact element is connected respectively to a printed circuit board contact and is seated against the shank of the screw. As long as the shank bridges the spacing of the two contact elements, an electrical connection exists between the two printed circuit board contacts. If this connection is interrupted, an attempt at tampering with the device is detected.

Tamper protection employing a plurality of contacted housing locking screws is known from US 2002/014962 A1. In this case the screws are connected electrically by way of contact elements. If a screw is unscrewed the connection is broken, thereby indicating the occurrence of tampering.

A tamper-proof multi-layer printed circuit board arrangement is known from EP 2 330 528 A2. A first layer is formed by a printed circuit board, the upper side of which is equipped with a cryptographic processor. A spacer layer applied across the surface of the printed circuit board has an aperture at the position of the processor. The spacer layer is covered by a further layer such that the processor is enclosed on all sides.

EP 0 540 376 A1 shows an arrangement having a printed circuit board which is held by means of a screw between two housing parts. Around an aperture serving to pass the screw through, the printed circuit board has two concentrically arranged

contact surfaces which in the assembled state are connected electrically by means of a washer. Removal of the screw and subsequently of the washer interrupts the connection, thereby causing an attempt at tampering with the arrangement to be detected.

An electronic device having particular security requirements is designed for example as an on-board information system, as disclosed in EP 2 466 682 A1.

The object of the invention is to specify an improvement compared with the prior art for an electronic device of the type mentioned in the introduction.

This object is achieved according to the invention by the features described in claim 1. Improvements are set down in dependent claims.

In this situation a first electrically conductive contact element contacts a first printed circuit board contact and is seated against the screw in the screwed-in state. In addition, a second electrically conductive contact element contacts a second printed circuit board contact and is seated against the screw in the screwed-in state such that when the screw is screwed in an electrical connection exists between the two printed circuit board contacts. When the housing is closed a safe and stable electrical connection of the two printed circuit board contacts is thus effected by way of the electrically conductive screw. As soon as the screw is unscrewed, said electrical connection is broken automatically, which brings about a change in state of the device. For example, an electronic circuit registers the interruption of the two printed circuit board contacts. There is no dedicated

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switch coupled to one of the housing parts. The blocking of a switch, for example by the injection of an adhesive, is therefore avoided. Altogether, the invention enables a simple and fault-tolerant construction of a secured device housing.

According to the invention, the contact elements are seated against the screw in such a manner that the electrical connection of the two printed circuit board contacts is made only when the screw is fully screwed-in. This prevents a situation in which only a slight opening of the device housing remains without effect. As soon as the housing parts are loosened by means of the screw, the electrical connection between the printed circuit board contacts is automatically broken with the intended effect of a change in device state.

In an embodiment of the invention the electronic device comprises a storage element and a microprocessor, where the storage element is at least partially erased as soon as the electrical connection between the printed circuit board contacts is interrupted. Such a measure is expedient in particular in the case of devices having particular security requirements in respect of integrity and authenticity. If for example confidential data or cryptographic keys are stored on the storage element, opening the device housing automatically results in the erasure of said data. Any undesired tampering with the device by a device user is reliably prevented in this manner.

A development provides that the electronic device is an on-board unit arranged in a vehicle. Such devices are utilized for example for toll collection and must therefore be protected against any unauthorized access. Since toll collection devices are produced in large quantities, the simple construction according to the invention of the housing protection is particularly advantageous here because a large number of assembly parts for detecting device tampering (for example switches) can be saved.

It is favorable if at least one contact element is designed as a metal spring. The contact element is then seated against the screw with a spring force which means that a stable vibration-resistant electrical connection is given.

In order to enable simple production, provision is advantageously made that at least one housing part is manufactured as an injection-molded plastic product and that

at least one of the contact elements is included in the injection molding.

In a development, each housing part has extensions which are designed as holders for the printed circuit board. The printed circuit board is fixed by means of said holders during the assembly of the housing such that no further fixing of the printed circuit board is necessary. Such extensions can for example be mounting domes around the mounting holes provided for fitting the screw.

It is moreover favorable if the first contact element is sandwiched between the printed circuit board and the first housing part. The same applies for the second contact element, which is favorably sandwiched between the printed circuit board and the second housing part. In this manner, an electrical connection is effected between the contact elements and the printed circuit board contacts in the course of assembling the housing.

A further favorable embodiment provides that the first contact element is sandwiched between the first housing part and the head of the screw. In addition it is advantageous if the second contact element projects into a mounting hole in the second housing part such that the end of the second contact element is seated against the shank of the screw when the screw has been screwed in. As soon as the screw has been screwed into the mounting hole and the screw head touches the housing, the electrical connection is produced between the printed circuit board contacts. Conversely, said electrical connection is broken as soon as the screw head is unscrewed only slightly. Such an embodiment is moreover not sensitive to

deformation of the housing because the electrical contacts are arranged directly at the screw fastening position.

The invention will be described in the following in exemplary fashion with reference to the attached figure.

The figure shows a schematic view of a section of an assembled housing. A first housing part 1 is joined by means of a screw 4 to a second housing part 2. The housing parts 1, 2 are preferably injection molded from plastic. They are designed as being thin-walled, with mounting domes 11, 12 being provided around the mounting holes. In addition, the mounting hole in the first housing part 1 has a cylindrical countersink. The head of the screw 4 is recessed in said countersink in the assembled state. The thread in the mounting hole in the second housing part 2 is favorably produced as a result of screwing in the screw 4.

The mounting domes 11, 12 of the two housing parts 1, 2 form a holder for a printed circuit board 3. For example, the mounting dome 12 of the second housing part 2 is stepped at its end, where the step forms a clearance fit with an opening in the printed circuit board 3. The printed circuit board 3 is fixed by the face of the mounting dome 11 of the first housing part 1 bearing down thereon. No additional fixing of the printed circuit board 3 is required.

The bearing faces of the printed circuit board 3 on the two mounting domes 11, 12 are utilized in order to establish an electrical connection to two contact elements 5, 6 in the assembled state. For this purpose the printed circuit board 3 has a printed circuit board contact 7, 8 around the opening on each side which are connected by way of conductor paths to an

electronic circuit. Each of said printed circuit board contacts 7, 8 contacts a correspondingly formed contact element 5, 6. The contact elements 5, 6 are favorably produced from spring steel and injection molded with the respective housing part 1, 2. In an alternative design, after injection molding of the housing parts 1, 2 the contact elements 5, 6 are inserted into recesses provided for the purpose.

The first contact element 5 connects the first printed circuit board contact 7 to a screw contact surface 9 which is present for example in the form of the annular underneath face of the head of the screw at the transition to the screw shank. In this situation the end of the contact element 5 is quasi a washer beneath the screw head but the inner edge of this disk does not touch the screw shank. Thus, an electrical connection exists between the screw 4 and the first contact element 5 only when the screw 4 is fully screwed in.

In the second housing part 2, the end 10 of the second contact element 6 is guided into the mounting hole in such a way that the fully screwed-in screw 4 automatically presses with its shank against said end 10 of the second contact element 6. An electrical connection between the screw 4 and the second printed circuit board contact 8 thus exists in the assembled state by means of the second contact element 6. The two printed circuit board contacts 7, 8 are then electrically connected to one another by way of the fully screwed-in screw 4.

The printed circuit board contacts 7, 8 are connected by way of conductor paths to an electronic circuit which is not illustrated. The latter comprises for example a storage element and a microprocessor. The electronic circuit with the

microprocessor is set up in order to detect an interruption in the electrical connection of the two printed circuit board contacts 7, 8 and to bring about a change in state of the electronic device.

In a device designed as an on-board unit for road tolling, confidential data is stored in the storage element. Said confidential data must be protected against access by the device user. As soon as the user makes an attempt to open the device by releasing the screw 4, he automatically interrupts the electrical connection of the two printed circuit board contacts 7, 8. An appropriately configured electronic circuit detects this interruption and erases the confidential data in the storage element. As a result the on-board unit is unusable and can for example only be reset to an original state by the manufacturer or toll operator.

CLAIMS

1. An electronic device having particular security requirements which comprises a printed circuit board (3), wherein the printed circuit board (3) is enclosed by a housing having two housing parts (1, 2) joined by means of screw (4), wherein a separation of the housing parts (1, 2) automatically causes a change in state of the electronic device, wherein a first electrically conductive contact element (5) contacts a first printed circuit board contact (7) and is seated against the screw (4) in the screwed-in state and wherein a second electrically conductive contact element (6) contacts a second printed circuit board contact (8) and is seated against the screw (4) in the screwed-in state, such that when the screw (4) is screwed in an electrical connection exists between the two printed circuit board contacts (7, 8), **characterized in that** the contact elements (5, 6) are seated against the screw (4) in such a way that the electrical connection of the two printed circuit board contacts (7, 8) is made only when the screw (4) is fully screwed in.

2. The electronic device as claimed in claim 1, **characterized in that** the electronic device comprises a storage element and a microprocessor and that the storage element is at least partially erased as soon as the electrical connection between the printed circuit board contacts (7, 8) is interrupted.

3. The electronic device as claimed in claim 1 or 2, **characterized in that** the electronic device is an on-board unit arranged in a vehicle.

4. The electronic device as claimed in one of claims 1 to 3, **characterized in that** at least one contact element (5, 6) is designed as a metal spring.

5. The electronic device as claimed in one of claims 1 to 4, **characterized in that** at least one housing part (1, 2) is manufactured as an injection-molded plastic product and that at least one of the contact elements (5, 6) is included in the injection molding.

6. The electronic device as claimed in one of claims 1 to 5, **characterized in that** each housing part (1, 2) has extensions which are designed as holders for the printed circuit board (3).

7. The electronic device as claimed in one of claims 1 to 6, **characterized in that** the first contact element (5) is sandwiched between the printed circuit board (3) and the first housing part (1).

8. The electronic device as claimed in one of claims 1 to 7, **characterized in that** the second contact element (6) is sandwiched between the printed circuit board (3) and the second housing part (2).

9. The electronic device as claimed in one of claims 1 to 8, **characterized in that** the first contact element (5) is sandwiched between the first housing part (1) and the head of the screw (4).

10. The electronic device as claimed in one of claims 1 to 9, **characterized in that** the second contact element (6) projects into a mounting hole in the second housing part (2) such that

it is seated against the shank of the screw (4) when the screw (4) has been screwed in.