A data carrier having an IC module and a method for producing such a data carrier

The present invention relates to a data carrier having an IC module for processing electrical signals, the IC module being disposed in the interior of the data carrier and connected via leads to elements for communication with peripheral devices, in particular contact surfaces.

German "auslegeschrift" no. 29 20 012 describes an identification card having an integrated circuit. The IC module is disposed together with its contact surfaces and leads on a separate carrier element. The carrier element is held, in the finished card, by elastic connecting elements in a recess in the card inlay. The recess in the card has a larger periphery than the carrier element. The elastic connecting elements provide the carrier element with a floating mounting in the card recess, so that it does not become wedged in the card recess even when subjected to great bending loads. This type of mounting effectively keeps bending stresses in the card away from the carrier element and thus from the sensitive electrical components such as the integrated circuit and the soldering joints.

A further data carrier with an integrated circuit is described in German "offenlegungsschrift" no. 31 31 216. The IC module here is also disposed together with its contact surfaces and leads on a separate carrier element. The carrier element has a relatively rigid design in order to protect the electrical components. For example, the parts may be cast into a rigid plastic part. The carrier element is connected with the card via an anchoring element. The anchoring element protrudes beyond the edge of the carrier element and is preferably firmly connected thereto. The area

of the anchoring element which protrudes beyond the carrier element is inserted between card layers and connected thereto. This way of attaching the carrier element to the card also keeps bending loads during use of the card away from the sensitive electrical components.

The protection of the IC module and the contact surfaces, leads and soldering joints is very good in the two above-described data carriers. Since these data carriers are generally supposed to be operable for a relatively long period of use (several years), the technical effort required for producing these data carriers is justified.

However, more and more data carriers have come into use recently which are intended to be valid for only a relatively short period of time. An example of such a data carrier is the so-called telephone card, used for making telephone calls without use of cash on special telephones. The customer purchases from an issuing office a card having a given value and thus a certain number of units of charge. For every telephone call a corresponding number of units is deducted electrically. When all units have been used up the card is invalid and is generally thrown away.

The efforts for embedding an IC module in the card as described above seem too great for such deduct or expire cards. On the other hand, these cards should also possess mechanical flexibility and a high degree of electrical reliability.

Therefore, the invention is based on the problem of proposing a data carrier having an integrated circuit in which the circuit and the communication elements or contact surfaces connected thereto via leads are protected against

mechanical stress, but which is easy and economical to construct and produce.

This problem is solved according to the invention by the features stated in the main claim.

The predetermined breaking points formed as a weakening or interruption in the card structure in the vicinity of the IC module, the leads and the contact surfaces (referred to as "IC area" in the following) cause this area to be mechanically decoupled to a large extent from the remaining card area. The weakenings or interruptions in the card structure between the IC area and the remaining card area lead to disturbances in the homogeneity of the card material which interrupt the bending stresses caused by deformation of the card, thereby keeping them away from the IC area to a large extent. Overstresses caused by strong bending during use of the card are "intercepted" by the predetermined breaking points before they lead to damage of the IC module or its leads, so that the card body may be damaged but not the electrical operation of the card.

The predetermined breaking points, which disturb the rigidity of the card structure by weakenings or interruptions, can be realized for example by reducing the cross section of the card. In the most simple case, the card has a thinner design, for example a stamping, along a line separating the IC area from the remaining card area. Further, the cross section of the card may only be reduced locally, for example by a perforation or one or more cutting lines. A further possibility of forming predetermined breaking points is to incorporate materials which do not connect, or only connect to a slight degree, with the remaining card material or are less rigid than the remaining card material and give

way under stress, thus keeping the bending stresses of the card away from the IC area.

It is guaranteed in all cases that the homogeneous card structure surrounding the IC area is interrupted or weakened in such a way that bending stresses acting on the card cannot fully affect the IC area beyond the dividing line.

The inventive solution exhibits several advantages over the cards known up to now. The newly proposed cards are characterized by a particularly simple structure. In particular, one can dispense with a separate carrier element and anchor the IC module together with the contact surfaces directly in the card.

If the card structure is to be disturbed in its homogeneity by special materials, these materials may be incorporated into the card independently of the electrical components since the predetermined breaking points and the IC area do not overlap. Thus, the most favorable conditions may be selected for both the incorporation of the electrical parts and the production of the breaking point.

If the homogeneity of the card structure is interrupted by a perforation, recesses or simply by cutting lines, the corresponding working steps are usually carried out after the IC module is incorporated into the card. Thus, the card may be produced by one of the methods known up to now and, independently therefrom, provided with the breaking points at a later time in a final operation, which expediently coincides with the cards being punched out of the so-called multiple copy sheet.

All the stated methods of forming the predetermined breaking points disturbing the homogeneous card structure are characterized by a simple and economical production, while sufficient protection of the sensitive electrical components is still guaranteed.

If the card should be subjected to great mechanical bending stresses some time it is deformed when a critical stress is exceeded, thereby causing the predetermined breaking point to be jolted, stretched or torn open. This makes the overstress recognizable on the card, providing the advantage that any mechanical overstressing is detectable in case of complaint, for example.

Further advantages and developments of the invention can be found in the subclaims and the embodiment examples, which shall be described in the following with reference to the figures, in which:

Fig. 1 shows a card having an embedded IC module and contact surfaces from the front,

Fig. 2 shows a card in a bent state in cross section,

Fig. 3 shows a schematic view of the bending stresses when the card is bent in different ways,

Fig. 4 shows the inventive weakening of the card material to interrupt the bending stress lines,

Figs. 5 to 7 show different embodiments of the invention.

Fig. 1 shows a card 1 from the front. The card contains one or more integrated circuits 2 which, in the example shown, are disposed between two contact surface areas 3 each having four single contacts 4, and connected to the contacts via leads not visible from the outside. IC module 2 is preferably disposed in the interior of the card where it is protected. The card as in Fig. 1 may be produced, for example, as described in patent application P 33 38 597, filed by the applicant.

The card is usually provided with printing 6 stating, for example, the value of an expire card.

The card corresponds to the norms applicable to credit cards and has, among other properties, a flexible design as prescribed by the norm. Since the card is subjected to a great variety of stresses in daily use, whereby differently directed forces act upon different places in the card, forces may arise in the interior of the card which lead to destruction of the IC module, the leads or the soldering joints.

These stresses coming about in daily use can be simulated to a certain extent in laboratory experiments, by subjecting the card to various alternating stresses by the action of forces 10, 11, as shown in Fig. 2 by way of example. In the following, some cases of stress which are known to arise during use of the card shall be demonstrated with reference to Fig. 3.

When the card is pressed together and thus bent by forces 12, 13 acting upon the short side edges as shown in Fig. 3a, the greatest bending stresses occur parallel to the long side of the card. In Fig. 3a these bending stresses are

indicated by three lines 20. The same bending and the same bending stresses also arise when the card is bent out of its flat position of rest by differently directed forces acting on three points, as shown by arrows 10, 11 in Fig. 2.

Similar bending stresses to those in Fig. 3a result when the card is bent by forces 24, 25 acting on its long sides. This case is shown in Fig. 3b. The bending stresses arising in this case are indicated by lines 21.

The bending stresses indicated by lines 20, 21 in Figs. 3a and 3b only hold strictly when the forces causing the bending act along the entire length of the side edges. When forces are applied at certain points, laterally directed bending stresses arise in addition to the bending stresses running between the points of application and indicated in Figs. 3a and 3b, thereby bending the card like a saddle surface. However, the differences in the card bending between forces applied punctually and linearly are small, so that the schematic views in Figs. 3a and 3b portray the real state of affairs quite correctly.

A further type of bending is to bend the card along a diagonal by forces 26, 27. The bending stresses thereby occurring are indicated in Fig. 3c. Depending on which of the opposite corners the forces are applied to, one of bending stress lines 22, 23 shown in Fig. 3c results. Instead of opposite corners being pressed together, there is a similar bending stress pattern when torsional forces are applied to opposite corners of the card.

In daily use, the stresses shown in Figs. 3a, 3b, 3c will usually not occur separately but in combination. The corner areas of the card have proved to be the areas least

subject to stress, which can advantageously be used for incorporating the sensitive IC module and the contact surfaces. The stresses on the card have proved to be smallest in these areas.

Fig. 4 shows by box 30 the area in which the IC module along with its leads and contact surfaces should preferably be incorporated. The figure also shows bending stress lines 20, 21, 22 which have already been explained with reference to Fig. 3. Although IC area 30 is subjected to less stress than the center of the card, for example, it is still necessary to take additional steps to protect the IC module.

For this purpose, IC area 30 and remaining card area 31 are decoupled mechanically as well as possible. This is accomplished according to the invention by a so-called predetermined breaking point which weakens or interrupts the homogeneous card material in the vicinity of the IC area. This also interrupts bending stress lines 20, 21, 22 so that the forces in action due to the stresses are transferred to IC area 30 in a greatly weakened form or, in the case of excessive forces, kept away from the IC area by deformation of the card structure. Fig. 4 indicates such an interruption in the bending stress lines by way of example in line 32.

The partial interruption or weakening of the card is usually designed in such a way that the predetermined breaking point is not made use of in normal use, i.e. under slight mechanical stress. The inventive card thus behaves like a previously produced card without any breaking point. Only when a certain bending stress is exceeded does the incorporated breaking point take effect, keeping the great mechanical stresses away from the IC area. The stress limit beyond which the breaking point is to take effect may be

varied within a wide range and thus adapted to the particular conditions at hand. The conditions are given, for example, by the mechanical stability of the IC module, which in turn depends on its size and shape.

Different embodiments of the inventive breaking point or zone are shown in Figs. 5, 6, 7. Each of these figures shows a section of a card 1 in which the contact surfaces and the IC module enclose an IC area 30.

In Fig. 5 the homogeneous card material is weakened, thereby forming a breaking point, along a line or zone 40 which extends diagonally to the IC area. Weakening 40 may, in the most simple case, consist in a thinner design of the card in this area, for example by means of a groove or stamping in the card surface. Instead of reducing the card cross section on one or both surfaces, one may also weaken the card in its inner structure. For example, the core material of the card may be omitted along weakening zone 40 in a three-layer card. During the lamination process, in which pressure and heat are generally used, the omitted area of the card core may be slightly closed by the flow of softening card material, which should be taken into consideration when dimensioning the omitted zone. In this embodiment the two card cover films constitute a unified, smooth surface, while the breaking point is arranged in the interior of the card.

Instead of omitting card material, one might also use material as a card core or additional thin separating layer in the area of zone 40 which does not connect, or only connects poorly, with the cover films or is less rigid than the remaining card material. For example, a thin strip of polyester or Teflon may considerably reduce the connection be-

tween the two card cover films. Further, one can embed a paper strip which connects with the PVC material but remains resilient in itself.

Fig. 6 shows a further embodiment of the invention in which IC area 30 is surrounded by a curved breaking point 41. This may be accomplished, in the most simple case, by a perforation 41 in the homogeneous card material. The local removal of card material reduces the rigidity of the card along perforation line 41 so that when the card is subjected to great bending stresses it is bent along perforation line 41. This reduces transmission of the bending stress to sensitive IC area 30 to an extent such that the IC module along with the contact surfaces and leads are protected from destruction.

Finally, Fig. 7 shows an embodiment which has proved to be particularly effective in practice. This embodiment is characterized by the fact that IC area 30 is largely relieved of the mechanical stress on the remaining card by recesses 42 in the card material in the vicinity of the IC area. In the example shown, recesses 42 are each arranged at the corners of the IC area. The IC area is thus only connected with the card by four narrow strips 43 of card material. Since the cards are usually made of flexible plastic, strips 43 constitute an elastic mounting for the IC area and serve as a breaking point at the same time. The arrangement of recesses 42 at the corners of the IC area serves in particular to keep diagonal bending 22 of the card away from the IC area, as was explained with reference to Fig. 3c.

Variations in the embodiment just described consist in providing only cuts in the card instead of recesses 42 which are preferably 0.2 to 0.5 mm wide. Further, it may suffice,

depending on the stress, to provide only the corner of the IC area pointing towards the middle of the card with a recess or cut, since it has turned out that most of the bending stress is kept away from the IC area when this corner is relieved.

The methods for producing cards with inventive breaking points have in common that they can be carried out independently of the incorporation of the IC module. Thus, the most favorable conditions may be set for both the design of the breaking point and the IC incorporation.

A paper strip or a film strip which does not connect with the remaining card material may be embedded in such a way that the card material is omitted in accordance with the weakening zone and the paper or film strip inserted in its place. The subsequent lamination of the card can be carried out under optimal lamination conditions particularly in the area of the embedded strip since the IC area, which may require different conditions (e.g. lower pressure), does not overlap with the remaining card area which also contains the breaking point.

If the recess in the card core layer is to be kept free instead of using the paper or film strip, attention must be paid that the recess is not closed by the flow of heated, and thus fluid, card material under the normally high pressure during hot lamination. This effect can be taken into consideration by dimensioning one or more recesses as well as the laminating conditions accordingly. When conventional PVC films and conventional lamination conditions are used, good results are obtained with recesses which are 0.5 to 2 mm wide. If the card layers are stuck together cold, the

size of the recesses remains unchanged during the adhesive process.

In the other embodiments presented, the breaking point is produced by weakening the homogeneous card structure after the IC module has been incorporated into the card. If a uniform reduction of the cross section of the card along a line is desired, this can be obtained in the most simple case by a stamping or by milling a groove. Punching and cutting are also carried out on the finished card by an accordingly shaped tool only after IC incorporation is completed.

Since plastic cards are usually produced in relatively large "multiple copy sheets", containing 21 (3 x 7) single cards for example, the punching of the recesses, perforations or cuts can preferably be carried out jointly with the punching of the cards out of the sheet, so that no additional working step is required. This method offers the further advantage that the punchings are always located at the same place in different cards so that narrow tolerances can be adhered to.

Claims

1. A data carrier in the form of a flexible standard card made of plastic having an IC module disposed in the interior of the card body and connected via leads to contact surfaces, the card surface having two areas and the IC module being disposed in one of these areas, which area is small relative to the area including the remaining card surface, and the two areas being separated from each other by a predetermined breaking point, characterized in that the area containing the IC module and the other card area are of homogeneous structure and made of identical materials of one and the same card.

2. The data carrier of claim 1, characterized in that the predetermined breaking point is designed as a weakening and/or interruption in the card structure which locally reduces the rigidity of the card.

3. The data carrier of claim 2, characterized in that the weakenings and/or interruptions in the card structure are obtained in an at least three-layer card by a cavity formed by the card cover layers and a recess in the middle card layer.

4. The data carrier of claim 2, characterized in that the weakenings and/or interruptions in the card structure are obtained by embedding an additional material having lower rigidity values than the surrounding card material and/or not connecting, or only connecting poorly, with the card material.

5. The data carrier of claim 2, characterized in that the weakenings and/or interruptions in the card structure

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are obtained by partly reducing the cross section of the card.

6. The data carrier of claim 5, characterized in that the reduction in the cross section of the card is obtained by perforations, recesses or cutting lines.

7. The data carrier of claim 5, characterized in that the reduction in the cross section of the card is obtained by making the card material thinner along a line.

8. The data carrier of claim 2, characterized in that the weakenings and/or interruptions are adapted to the outline of the IC module and to the contact surfaces.

9. A method for producing the data carrier of claim 1 in the form of a flexible standard card made of plastic having an IC module disposed in the interior of the card body and connected via leads to contact surfaces, the card surface having two homogeneously constructed areas and the IC module being disposed in one of these areas, which area is small relative to the area including the remaining card surface, and the two areas being separated from each other by a predetermined breaking point, characterized in that after the data carrier optionally comprising a plurality of layers has been laminated it is reduced in its cross section by being worked from outside to produce predetermined breaking lines in the form of a local weakening of material.

10. The method for producing a data carrier of claim 9, characterized in that the cross section of the data carrier is reduced by cuts, punchings or perforations.

11. The method for producing a data carrier of claim 9, characterized in that the cross section of the data carrier is reduced by a stamping.