The invention relates to a flexible printed circuit and is most particularly suited to electronic microcircuit cards, the thickness of which complies with ISO (International Standards Organisation) standards for credit cards, and to a card incorporating such a circuit.

An electronic microcircuit card is a rectangular single-part or multilayer board made of plastic material, which incorporates electronic microcircuits and has external contacts for connecting the electronic microcircuits to a card processing device. These microcircuits can be intended for very diverse functions such as, for example, debit and credit banking transactions, the allocation of telephone units or confidential inputs in a protected environment. They generally constitute processing and/or memory circuits of varying complexity according to the use for which they are intended. In practice, they are formed on at least one silicon wafer commonly known as an integrated circuit or chip.

One embodiment of an electronic microcircuit card consists of fixing into a cavity in the card a printed circuit carrying the integrated circuit and the contacts of the card. The printed circuit is made from a thin sheet of flexible material such as polyester, impregnated fibreglass, or else a plastic material of sufficient flexibility. Given that the printed circuit provided with contacts and the integrated circuit has to be incorporated into a card the standard thickness of which is 0.762 mm ± 10%, the printed circuit sheet has to be thin, of the order of 130 micrometres, for example. The flexible material of the sheet and its thinness make it an element compatible with the flexibility required by the ISO for cards of the credit card type.

The invention relates more specifically to a flexible printed circuit, the end of one face of which carries the integrated circuit and the other end of the other face of which has the card's contacts. The contacts are thus offset relative to the integrated circuit by the respective conductors formed on one face of the sheet. For reasons of convenience, the face on which the contacts are accessible at the level of the card is termed the

upper or outer face of the sheet or the printed circuit, the other face being said to be lower or inner. Furthermore, the axis joining the card's contacts and the integrated circuit is termed the axis of the circuit.

According to one embodiment, the conductors and associated contacts are formed on the upper face of the sheet. The integrated circuit is soldered to the corresponding ends of the conductors arranged so as to project into an aperture provided on the sheet. These ends of conductors often form regions making it easy to connect them to the corresponding terminals of the integrated circuit. The advantage of this printed circuit is that it is thin, because the thickness of the integrated circuit is not added to the thickness of the sheet.

According to another embodiment, it is the face of the integrated circuit opposite that carrying the terminals which is fixed to the lower face of the sheet, and the terminals of the integrated circuit are then connected to the corresponding ends of the conductors of the sheet by conducting wires. This technique is called "Wire Bonding".

However, in these various embodiments the external arrangement of the circuit's conductors sometimes requires the use of a protective film covering only the printed circuit but, with greater advantage, spread out over the whole face of the card, particularly when there is a risk of the conductors of the printed circuit being near or in contact with a magnetic track. It is then impossible to deposit the magnetic track unless it is supported by a homogenous material. Of course, in this case the film is provided with apertures to give access to the contacts. A variant embodiment consists of forming the conductors on the lower face of the sheet. The integrated circuit is soldered to the corresponding ends of the conductors whilst, at the other end, the contacts are accessible through apertures made in the sheet. This variant does not require the use of a film but it has the disadvantage of adding the thicknesses of the sheet and the integrated circuit.

Offsetting the contacts relative to the integrated circuit may be preferred for several reasons, particularly in order to comply with standards for positioning the contacts along the long median line of the card, near a short side. Thanks to this arrangement, the integrated circuit can remain in a corner of the card where the constraints of flexion and torsion are significantly lower than near the contacts. ISO standards also decree that the contacts must be six or eight in number, distributed equally in two rows parallel to the short side of the card. According to another ISO provision, the contacts must have a predetermined minimum area, and be rectangular in shape. The conductors normally leave the contacts and join the respective terminals of the integrated circuit in what is obviously the most direct and most compact way. To comply with international standards, the card must be capable of undergoing without damage a given number of flexions, made along either of the card's two median lines. More draconian requirements may be defined contractually. In these circumstances, it proves that printed circuits with offset contacts of a conventional design already do not comply properly with the minimum standards. As a general rule, flexions affecting the axis of the circuit are the most likely to be damaged. Damage is characterised by cuts at the level of the conductors. Studies have therefore been carried out to search for the best metallurgy and the best method of manufacturing the conductors. The results obtained have proved unsatisfactory at both the quality and reliability level.

The invention gives a flexible printed circuit the means for assuring long-lasting quality of the electrical connections between the contacts and the circuit terminals, in spite of the constraints exerted by flexion of the printed circuit.

It is particularly well-suited to the installation which is to be described, in which the contacts are near the card's long median line, close to a short side, and in which the circuit is at the same time near a corner of the card, but it also applies to different installations, particularly where the contacts are even nearer the long median line and a short side of the card, whereas

the integrated circuit is nearer the centre of the card, on the long median line; more generally, it applies to all possible installations in which the axis of the circuit is parallel to one of the sides of the card (long or short) and whether or not the installation of the external contacts complies with the standards decreed in this field, or else other installations in which the axis of the circuit is no longer parallel to either of the card's sides.

According to the invention, a flexible printed circuit provided with conductors connected to contacts distributed over a first zone and intended for a connection made in a second zone, remote from the first, said conductors leaving the respective contacts substantially perpendicular to the axis of the printed circuit joining the two zones, is characterised in that said conductors then form loops or meanderings relative to this axis, as far as the second zone.

This structure makes it possible to reduce to a minimum the sections of conductors in a straight line arranged parallel to said axis of the printed circuit sheet, so that when the circuit undergoes flexions, the meanderings confer a certain freedom to the conductors which prevents them from being stretched. In the worst case, flexion which was too exaggerated would possibly lead to one of the conductors becoming unstuck between the contacts and the connection zone, but no cut would appear, so that electrical continuity would be ensured.

A flexible printed circuit according to the preamble of Claim 1 is known from document EP-A-0 207 853.7.

Other characteristics and advantages of the invention will emerge from the following description, given by way of example and with reference to the attached drawings, in which:

- Figure 1 is a plan of a first variant embodiment of a flexible printed circuit according to the invention;

- Figure 2 is a section along the line II-II of the flexible printed circuit shown in Figure 1 and mounted on a card of the credit card type, illustrated in part;
- Figure 3 is a plan of the overall card shown in Figure 2;
- Figure 4 is a plan of a second variant embodiment of a flexible printed circuit according to the invention;
- Figure 5 is a plan of an embodiment of a card incorporating the circuit shown in Figure 4.

Figures 1 to 3 illustrate a flexible printed circuit 10 according to the invention, intended for a card 11 of the standard credit card type and constituting an electronic microcircuit card.

As illustrated by Figure 1, the electronic microcircuits are contained in an integrated circuit 12 fixed to the printed circuit 10. Traditionally, the printed circuit 10 is made from a thin, flexible, rectangular sheet 13, generally of plastic material. In the example, the upper face of the sheet 13 carries six conductors 14, only three of which are completely shown for reasons of clarity, six contacts 15 respectively being connected to six contact regions 16 arranged so as to project around an aperture 17 made in the sheet 13. The aperture 17 contains the integrated circuit 12, the terminals 18 of which are soldered to the respective regions 16. In the example the axis A which connects the zone with the contacts 15 to the zone with the regions 16, is merged with the long median line of the sheet, so that the axis A of the circuit is here the long median line. Furthermore, each zone is close to one of the ends of said median line.

In the example illustrated in Figure 2, the terminals 18 are soldered direct to the contact regions 16 of the printed circuit. A variant not shown uses the technique described in the preamble of the present application, according to which the face of the integrated circuit opposite that carrying the terminals 18 faces the contact regions 16, and in which the terminals 18 are then connected to the regions 16 by conducting wires.

In the embodiment illustrated, the integrated circuit 12 is assumed to be of the MOS (Metal Oxide Semiconductor) type, and a polarisation tag 19 is then fixed to the back of the integrated circuit and connected to an extension of one region 16, generally representing earth. The aperture 17 is placed at one end of the rectangular sheet 13 and is divided by the axis A of the circuit. The contacts 15 are placed in an area remote from the aperture 17 and placed on the axis A at the other end of the sheet 13. The contacts 15 are arranged in two parallel rows, preferably equidistant on either side of the axis A. The same is true of the regions 16. The contacts 15 and the regions 16 illustrated are rectangular in shape, their widths being parallel to this axis. The conductors connecting the contacts 15 to the regions 16 are thin and narrow compared with the width of the contacts satisfying ISO standards. For example, the conductors can have a width of the order of 300 micrometres.

A production example of an electronic microcircuit card 11 incorporating the printed circuit 10 shown in Figure 1 is illustrated in Figures 2 and 3. The card 11 is made of a board 20 made of flexible material, the dimensions of which comply with ISO standards. The board 20 is rectangular in shape, with a long median line M and a short median line M'. It can be single-part as illustrated, or multilayer. One face of the board 20 has a cavity 21 suitable for housing the printed circuit 10 provided with the integrated circuit 12 so that the upper face of the printed circuit 10 is substantially coplanar with the corresponding face of the board 20. The whole of this face is then covered with a film 22 provided with apertures 23 at the contacts 15 so that they can be connected to an external processing device. As shown in Figure 3, advantage is normally taken of the printed circuit 10 by placing it in the card 11 so that the axis A is parallel to a short side of the card and so that the contacts 15 are placed near this side, in its median zone. In the example illustrated, the contacts 15 accessible through the openings 23 are distributed on either side of the card's long median line M.

The printed circuit 10 and the card 11 which have just been described are conventional. The invention consists in the fact that the conductors 14 leave the respective contacts 15 perpendicular to the axis A of the printed circuit 10 and subsequently form loops or meanderings relative to the axis A. More specifically, each conductor 14 is composed of a part 14a adjacent to the respective contact 15 and pointing in a direction B substantially perpendicular to the axis A. On the other side, each conductor 14 arrives in a part 14b at the corresponding region 16 in a direction which is also substantially perpendicular to the axis A. In the intermediate part 14c, each conductor has at least one loop or meandering relative to the axis A. By loop or meandering is meant a non-linear form having no angle along the course of each conductor.

In fact, as far as possible, there are no sections in a straight line parallel to the axis of the printed circuit connecting the zone where the contacts 15 are located, and the zone where the regions connecting to the terminals 18 of the integrated circuit are located, and the length of the conductors is thus extended relative to a direct course from the contacts 15 to the regions 16, which makes it possible to compensate for the stretching which occurs during flexion, and prevents their breaking. Furthermore, angles on the course of the conductors would behave as so many points likely to break during flexion, which would lead to deformation at the angles. For this reason, the course of the conductors is extended by making loops or meanderings which do not themselves comprise such points likely to break.

Figure 4 illustrates a variant of the printed circuit, in which the contacts 15 are arranged in two rows perpendicular to the axis A, in a first zone of the thin sheet, and the connecting regions 16 are located in a second zone remote from the first, also near the axis A; furthermore, this time, it is the length of the contacts 15 which is parallel to the axis A of the sheet.

This variant allows the standard for installing the contacts 15 relative to the card, for example, to be preserved, that is, by

arranging the rows parallel to one of the short sides of the card, but this time bringing the integrated circuit near the centre of the card. Such an installation could be envisaged in future for a specific technical reason.

In order to allow all the conductors 14 to leave the contacts 15 substantially perpendicular to the axis A, the innermost contacts of a row have their dimension parallel to the axis A greater than that of the outermost contacts, such that the innermost contacts project relative to the outermost contacts and hence are accessible, perpendicular to the axis A, to the sections 14a of conductors.

Seen from above, the card 11 incorporating such a printed circuit 10 would have the appearance illustrated by Figure 5. In this case, the axis A of the printed circuit 10 would be merged with the long median line M of the card 11, and the contacts 15 would comply with current standards. The board 20 made of flexible material constituting the body of the card 11 could have the same structural characteristics as those illustrated by Figure 3. In particular, it could be covered with a film 22 provided with apertures 23 at the contacts 15 so that they can be connected to an external processing device.

In the example illustrated in Figure 5, the axis A of the printed circuit is merged with the card's long median line M, such that the chip is near the centre of the card, also on the long median line. Of course, it is possible to use the variant illustrated in Figure 4 in all cases where it would be necessary for any reason to place, for example, the contacts near a corner of the card, while respecting the arrangement dictated by current standards and the chip simultaneously near a long side, and a short median line M' of the card.

But it is clear that the illustrations which have been given are not in any way limitative and, in particular, a change in standards for the arrangement of the contacts requiring that the rows are no longer parallel to a short side of the card, but to a long

side, would for example mean that the second variant would be used to place the contacts on the long median line and the chip in a corner, or else that the first variant described would be used to position the contacts 15 near one end of the long median line M of the card and the integrated circuit near the centre of the card.

Furthermore, it is important to note that the arrangement of either the widths or the lengths of the contacts 15, parallel to the axis A, as mentioned respectively in relation to Figures 1 or 4, does not contribute anything to the invention as is not necessary. It simply makes it possible to comply with the current standards for installing the contacts 15 on the card since the printed circuit is placed on it in accordance with the embodiments illustrated by Figures 3 or 5 respectively. The same is true of the rectangular shape of the contacts 15, which is not necessary.

The invention makes it possible to avoid as far as possible that sections of conductor in a straight line are parallel to the axis A of the printed circuit 10.

The advantages of the invention are as follows. According to ISO standards or by agreement an electronic microcircuit card must undergo without damage a predetermined number of flexions made along the long median line M of the card and the same number of flexions around the short median line M'. Experience reveals that flexions of the card 11 which affect the axis A of the printed circuit soon become prejudicial when the printed circuit 10 is produced conventionally. Breaks form at the level of the printed circuit conductors, which render any processing of the card impossible or errored. A large number of tests have been carried out, the configuration and metallurgy of the conductors being varied. The arrangement according to the invention ensures optimum reliability of the electrical connection made by the conductors 14 on a card 11 when it undergoes a large number of flexions around its two median lines M, M', which affect the axis A of the printed circuit.

* C L M S *

CLAIMS

1. A flexible printed circuit (10) provided with conductors (14) connected to contacts (15) distributed over a first zone of the circuit and intended for a connection made in a second zone of the circuit, remote from the first, said conductors (14) leaving the respective contacts (15) substantially perpendicular to the axis (A) of the printed circuit joining the two zones, characterised in that said conductors then form loops or meanderings relative to this axis, as far as the second zone.

2. A printed circuit according to Claim 1, characterised in that the contacts (15) are distributed over the first zone in two rows parallel to the axis (A) of the printed circuit.

3. A printed circuit according to Claim 1, characterised in that the contacts (15) are distributed in two rows parallel to each other and perpendicular to the axis (A) of the circuit, and in that the innermost contacts of the contact zone have their dimension parallel to said axis (A) greater than the corresponding dimension of the outermost contacts, such that each contact (15) is accessible by a section (14a) of conductor arriving at the first zone, perpendicular to the axis (A).

4. A printed circuit according to one of Claims 1 to 3, characterised in that the contacts (15) are distributed over the first zone uniformly on either side of the axis (A) of the printed circuit.

5. A printed circuit according to one of Claims 1 to 4, characterised in that the conductors arrive substantially perpendicular to the axis (A) of the printed circuit at regions (16) situated in said second zone.

6. A printed circuit according to Claim 5, characterised in that the regions (16) are distributed over the second zone uniformly on either side of the axis A of the printed circuit.

7. A printed circuit according to claims 5 or 6, characterised in that, in said second zone, it carries an integrated circuit (12) provided with terminals (18) each connected to one of the regions (16).

8. A printed circuit according to Claim 7, characterised in that the integrated circuit is placed in an aperture (17) made in said second zone.

9. An electronic microcircuit card (11), characterised in that it incorporates a printed circuit as defined by one of Claims 1 to 8.

10. A card according to Claim 9, characterised in that the axis (A) is parallel to one median line (M') of the card and the contacts (15) are situated close to the other median line (M) of the card.

11. A card according to Claim 9, characterised in that the axis (A) is parallel to a short side of the card and the short median line (M'), and in that the contacts (15) are situated close to the long median line (M) of the card, near one of its ends.

12. A card according to Claim 9, characterised in that the axis (A) is merged with the long median line (M) of the card and in that the contacts (15) are close to one of the ends of said median line.