

The subject-matter of the present invention is a device for coupling components which is suitable for carrying a component, and which is for example intended to be connected to other devices of the same type, which are each suitable for carrying a component. The invention also concerns a functional module comprising a plurality of such coupling devices.

In the above and in what follows, the general term "component" is given to any active or passive component, any discrete component or any assembly of components forming an integrated circuit, which comprises connection zones disposed on at least part of a substantially plane surface.

To produce an electrical circuit, it is necessary to interconnect components. For present equipment, efforts are being made to make such connections in as compact a way as possible. It is also of interest to produce standardised equipment or else to find a compromise between compactness and standardisation, these two results often being antinomic.

Multi-layer printed cards are known: these are composed of stacked insulating boards assembled together; each board comprises electrically conducting tracks made at least on one face, the tracks of all the boards being for example produced on faces oriented towards the same side of the stack; the tracks of various boards are interconnected by metallised holes; components are connected to certain of these tracks, for example through the intermediary of metallised holes; finally, the printed circuit comprises means for connection with the outside, known in themselves. Such a device is known, for example, from FR-A-2 305 9 .

The number of layers, the design of the tracks on each layer and the positioning of the metallised holes are determined according to the applications of the printed circuit, that is, the desired interconnection.

The subject-matter of the invention is a device for coupling components which is more standardised than a printed circuit.

This device for coupling components comprises stacked, assembled insulating sheets on which conducting tracks which are substantially rectilinear and parallel to each other are produced on the faces oriented towards a predetermined side of the stack, the tracks of two adjacent sheets being substantially perpendicular to each other. The design of the tracks on each sheet is therefore independent of the device's application. This device nevertheless makes it possible to produce various interconnections between components thanks to its modular nature: this device is suitable for carrying a component and being connected to other devices of the same type, themselves suitable for carrying a component; indeed, the device comprises connection zones for a component, positioned on that one of the faces comprising tracks which is free, and the tracks on each sheet are extended to the edge of the latter thus forming connection zones with the outside. The device further comprises connection means between the connection zones for a component and the tracks of the other faces.

More specifically, the invention has as its subject-matter a device for coupling components comprising:

- a plurality of first sheets stacked up, made of an electrically insulating material, each first sheet comprising a plurality of electrically conducting tracks produced on a first one of its faces, all said first faces of the first sheets being oriented towards the same side;
- mechanical assembly means for the first sheets;

the device being characterised in that:

- the conducting tracks of a given first sheet are substantially rectilinear and substantially parallel to each other;
- the conducting tracks of two adjacent first sheets are substantially perpendicular;

and in that it further comprises:

- on that one of said first faces which is free, connection zones for a component;

- electrical connection means between tracks belonging to said first faces which are not free and said zones for connecting a component;
- on the edge of each of the sheets, connection zones with the outside positioned in the extension of said conducting tracks.

The invention also concerns a functional module comprising a plurality of such devices for coupling components.

Specific points, particular features and various embodiments of the invention will become apparent during the following description, with the aid of the attached figures which represent:

- Figure 1, an embodiment of a device for coupling components according to the invention, represented in isolation;
- Figure 2, the device of Figure 1 associated with the component connected thereto;
- Figure 3, a first section of an embodiment of a functional module according to the invention;
- Figure 4, a second section of the device in Figure 3.

On these various figures, on the one hand, actual scale has not been respected and, on the other hand, the same references relate to the same elements.

Figure 1 represents an exploded view, as shown by the arrows 7, of a first embodiment of a device for coupling components according to the invention.

This device comprises four electrically insulating sheets 1, 2, 3 and 4 stacked up, on each of which electrically conducting tracks 11, 21; 31 and 41 are produced, for example, by screen-printing; these tracks are located on those faces of the sheets 1, 2, 3 and 4 which are oriented towards a given side such as, for example, towards the top of the device which, in Figure 1, is located on the side of the sheet 1. The tracks of a given sheet are substantially rectilinear and parallel to each other.

The tracks on two adjacent sheets are substantially perpendicular: in a geographical reference 5 comprising the four cardinal points, the tracks 11 and 31 of the sheets 1 and 3 are for example oriented in the east-west direction (E/O); the tracks 21 and 41 of the sheets 2 and 4 are then oriented in the north-south direction (N/S). Holes 6, substantially perpendicular to the stack of sheets, connect tracks belonging to the sheets 2, 3 or 4 to zones on the free face of the sheet 1, as shown schematically by the arrows 8 and 9: in Figure 1, eight holes connect tracks on the sheet 2 to the sheet 1 (indicated by the arrow 8) and four holes connect tracks on the sheet 3 to the sheet 1 (indicated by the arrow 9).

The device in Figure 1 is intended to receive, on the side of the sheet 1, a component, the connection zones of which are for example disposed in a substantially regular grid Q: for this purpose the strip 1 comprises either ends 12 of tracks 11 or else ends 16 of the holes 6 placed in substantially the same grid Q; these ends 12 or 16 of tracks or holes constitute connection zones for a component which are for example soldered to the connection zones of the component: for this purpose the holes 6 are for example filled with an electrically conducting material (for example a metal), the surfaces of these filled holes thus constituting the ends 16 of holes 6.

The grid Q of zones for connecting a component of the device fixes the number and distribution of the tracks on the sheet 1 which are connected to ends 12 and the tracks on the other sheets which are connected to holes 6. The number and distribution of the other tracks depend on the application of the device.

Filling the holes 6 with an electrically conducting material further performs a function of mechanically assembling the sheets which are electrically connected to the free face of the sheet 1; in the case of Figure 1, such filling assembles together the sheets 1, 2 and 3; the sheets not connected to the free face of the sheet 1, such as the sheet 4 in Figure 1, are assembled to the other sheets, for example by adhesive.

Filling the holes 6 also ensures the dissipation of heat within the device.

On the other hand, to connect the device in Figure 1 with the outside, for example to other analogous devices, themselves also suitable for carrying other components, the tracks of each of the sheets are extended to the edge of these sheets in zones described hereinafter as zones for connection with the outside, and given the references 10, 20, 30 and 40.

The device in Figure 1 therefore ensures the transmission of signals between said zones for connecting a component positioned on the free face of the sheet 1 (that is, the ends 12 of tracks 11 or the ends 16 of holes 6) and connection zones with the outside (that is, extensions of the tracks to the edge of the sheets) which point to the north, south, east or west of the device in the geographical reference 5. In the example illustrated by Figure 1, the device comprises sixteen connection zones, of which:

- two are connected to the east and leave via the sheet 1;
- two are connected to the west and leave via the sheet 1;
- four are connected to the north and leave via the sheet 2;
- four are connected to the south and leave via the sheet 2;
- two are connected to the east and leave via the sheet 3;
- two are connected to the west and leave via the sheet 3.

The sheet 4 of the device in Figure 1 makes it possible to ensure "direct" transmission of signals, that is, without passing through the component coupled to the device in the manner described above: indeed the device is intended to be inserted into an assembly, for example in a functional module as described below, and it may be necessary to produce tracks 40 directly crossing the device. The number of sheets in the device therefore depends on the application of this device.

Figure 2 illustrates more specifically the functioning of the device in Figure 1: indeed, it represents the device in Figure 1 assembled, as well as a component 50, represented as being moved away from the coupling device as indicated by the broken lines. Because of the respective sizes of the connection zones of the component 50 (not represented in Figure 2) and the connection zones for 12 and 16 of the coupling device (described above), it may prove necessary to interpose interconnection and attachment means 60 between the component 50 and the coupling device; this is particularly true when the component is an integrated circuit: the manufacturing precision of the integrated circuit's terminals is then clearly greater than that which can be achieved during the manufacture of a coupling device according to the invention.

These interconnection and attachment means 60 are for example composed of a sheet, the two faces 65 and 61 of which are respectively positioned against the face 56 of the component which comprises connection zones and against the free face of the sheet 1. These two faces 65 and 61 each comprise connection zones (not shown in Figure 2) with a manufacturing precision intermediate between that of the connection zones for the component and that of the ends 12 of the tracks 11 or the ends 16 of the holes 6. The connection zones of the faces 65 and 61 are electrically connected by paths crossing the sheet 60. Preferably, at least part of these paths ensures a displacement substantially parallel to the faces 65 and 61 of the second sheet. On the other hand, the connection zones of the faces 65 and 61 are for example soldered respectively to those of the component 50 and to the ends 12 or 16 of tracks 11 or holes 6, which further ensures mechanical attachment between the component 50, the sheet 60 and the coupling device.

According to a preferred embodiment, the interconnection and attachment means 60 are composed of a known interconnection device such as that described in EP-A-0 353 114: the faces 65 and 61 represented in Figure 2 are then respectively the first face and the second face of the first variant (comprising a sheet) of the known interconnection device, or else the first face of the first

sheet and the second face of the nth sheet of the second variant (comprising n sheets) of the known interconnection device.

Signals can therefore be transmitted in the directions indicated by the arrows 100 between the component 50 and the outside, or else directly cross the component, as explained above, in the direction indicated by the arrows 200, that is, in the example in Figures 1 and 2, in the north-south direction.

Figure 3 and 4 represent respectively a first and a second section of an embodiment of a functional module according to the invention, comprising a plurality of components according to the invention such as, for example, that in Figures 1 and 2. The section plane of Figure 4 is indicated in Figure 3 by the arrows A-A. Reciprocally, the section plane of Figure 3 is marked by the arrows B-B in Figure 4. Figures 3 and 4 are described simultaneously.

The functional module described comprises for example twelve coupling devices 91. To each coupling device is connected and attached a component 50, for example by interconnection and attachment means 60 such as those mentioned in the description of Figure 2.

The coupling devices 91 are juxtaposed at the bottom of an enclosure 81, one side wall 71 of which is for example composed of a connector suitable for providing an electrical connection with the outside. The enclosure also contains the components 50 and the interconnection and attachment means 60. It comprises a lid 72 constituted by for example a plate of heat-conducting material, referred to below as a cold plate; this plate performs the function of dissipating heat outside the functional module and of making this functional module rigid. The edges of the coupling devices 91 are kept in contact with each other by compression means 92 comprising for example springs known in themselves.

According to a known embodiment, the components 50 are substantially square sheets; the interconnection means 60 and the coupling devices 91 are also substantially square; the dimensions of the components 50 are substantially the same as those of the interconnection means 60 and are smaller than those of the coupling devices 91; spaces 93 are thus left free inside the enclosure; some of these free spaces 93 can for example be used to house channels within which there circulates a liquid coolant; these channels are preferably in contact with the cold plate 72, and improve the dissipation of heat outside the functional module. In order to dissipate even more heat, it is further possible to distribute a heat-conducting material in the free spaces not containing channels 93; in this case, the cold plate 72 has the function of sealing the functional module.

By way of example, the components 50 are integrated circuits, and each of them is connected to a capacitor 51 performing a decoupling function, such as for example a multi-layer capacitor, known in itself by the person skilled in the art. Such a capacitor 51 has for example the form of a substantially square sheet and preferably has substantially the same dimensions as the integrated circuit 50. The capacitor 51 is placed inside the enclosure 81 against the face 57 of the integrated circuit 50 (which is opposite the face 56 carrying connection zones and positioned against the interconnection and attachment means 60). The capacitor 51 and the integrated circuit 50 are for example interconnected and attached in the manner described in FR-A-2 638894 .



## C L A I M S

## 1. A device for coupling components comprising:

- a plurality of first sheets (1, 2, 3, 4) stacked up, made of an electrically insulating material, each first sheet (1, 2, 3, 4) comprising a plurality of electrically conducting tracks (11, 21, 31, 41) produced on a first one of its faces, all said first faces of the first sheets (1, 2, 3, 4) being oriented towards the same side;
- mechanical assembly means (6) for the first sheets (1, 2, 3, 4);
- the conducting tracks (11, 21, 31, 41) of a given first sheet being substantially rectilinear and substantially parallel to each other;
- the conducting tracks (11, 21; 21, 31; 31, 41) of two adjacent first sheets being substantially perpendicular;

characterised in that it further comprises:

- on that one of said first faces which is free, connection zones (12, 16) for a component (50);
- electrical connection means (6) between tracks (21, 31) belonging to said first faces which are not free and said connection zones (12, 16) for a component (50);
- on the edge of each of the sheets (1, 2, 3, 4), connection zones with the outside (10, 20, 30, 40) positioned in the extension of said conducting tracks (11, 21, 31, 41).

2. A device according to Claim 1, characterised in that the assembly means (6) for the first sheets (1, 2, 3, 4) and the means (6) for connection between the tracks (21, 31) belonging to said first faces which are not free and said zones (12, 16) for the connection of a component comprise holes filled with an electrically conducting material.

3. A device according to Claim 2, characterised in that the assembly means (6) for the first sheets (1, 2, 3, 4) further comprise adhesive between the sheets (4), the tracks of which



are not connected to said zones (12, 16) for connecting a component and the adjacent sheets (3).

4. A device according to one of Claims 1 to 3, characterised in that the zones (12, 16) for connecting a component comprise ends (12) of tracks (11) positioned on that one of said first faces which is free, and ends (16) of filled holes (6).
5. A device according to one of the preceding claims, characterised in that the tracks (11, 21, 31, 41) are narrow bands of said first faces of the first sheets (1, 2, 3, 4) which are screen-printed.
6. A device according to one of the preceding claims, characterised in that said zones for connection with the outside (10, 20, 30, 40) are narrow screen-printed bands.
7. A functional module, characterised in that it comprises:
  - a plurality of components (50);
  - a plurality of juxtaposed coupling devices (91) according to one of the preceding claims;
  - interconnection and attachment means (60) between the components (50) and the coupling devices (91);
  - mechanical assembly means (81, 71, 72, 92) for the coupling devices ensuring contact between their edges;
  - means (71) for connecting the functional module with the outside.
8. A module according to Claim 7, characterised in that the mechanical assembly means (81, 71, 72, 92) comprise:
  - an enclosure (81) at the bottom of which the coupling devices (91) are juxtaposed, containing the components (50) and the interconnection and attachment means (60);
  - compression means (92).



9. A module according to Claim 8, characterised in that the interconnection and attachment means (60) comprise at least one second sheet, one face of which (65) is positioned against that one (56) of the faces of the component (50) which comprises connection zones and itself comprises first connection zones positioned facing those of the component, the other face of which (61) is positioned against that one of said first faces of the coupling device which is free and comprises second connection zones positioned facing the zones (12, 16) for connecting a component of the coupling device (91), the first and second connection zones of the second sheet being electrically connected by paths ensuring at least in part a displacement substantially parallel to the faces of the second sheet, the connection zones of the second sheet having a manufacturing precision intermediate between that of the connection zones for the component (50) and that of the zones (12, 16) for connecting a component of the coupling device (91).
10. A module according to Claim 9, characterised in that the dimensions of the faces of the second sheet and those of the component (50) substantially parallel to the faces of the second sheet are smaller than those of said first sheets (1, 2, 3, 4) of the coupling device (91), which produces free spaces (93) in the enclosure (81).
11. A module according to one of Claims 9 to 10, characterised in that said interconnection and attachment means (60) further comprise solderings made between said first connection zones of said second sheet and the connection zones for the component (50), and between said second interconnection zones of said second sheet and the zones (12, 16) for connecting a component of the coupling device (91).
12. A module according to one of Claims 7 to 11, characterised in that it further comprises cooling means.



13. A module according to Claim 12, characterised in that the cooling means comprise a cold plate (72) constituting one of the walls (71) of the enclosure (81).
14. A module according to one of Claims 12 or 13, characterised in that the cooling means comprise channels made in said free spaces (93) and within which circulates a liquid coolant.
15. A module according to one of Claims 12 to 14, characterised in that the cooling means comprise a heat-conducting, electrically insulating material distributed inside the enclosure (81) around the coupling devices (91), the components (50), and said interconnection and attachment means (60).
16. A module according to one of Claims 7 to 15, characterised in that each component (50) is an integrated circuit and in that the module further comprises a plurality of capacitors (51) performing a decoupling function for the integrated circuits (50), one capacitor (51) being connected and attached to each of the integrated circuits (50).