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Connector for a plurality of switching assemblies with compatible interfaces

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The invention relates to a connector for the fixing and contact-making of switching assemblies having contact areas and mutually compatible interfaces on a substrate, comprising an insulating body, a plurality of receptacle devices formed in the insulating body and serving for the arrangement of switching assemblies, contact elements arranged at inner areas of the receptacle devices and opposite the respectively corresponding contact areas on the switching assemblies, and contact devices for the electrical contact-making of signal lines arranged on or in the substrate.

Modular electronic systems with a variable configuration are usually provided with a motherboard with one or a plurality of slots. Depending on the requirements made of the system or on the expansion level of the system, the slots are equipped with a respective modular component or remain vacant. In this case, the interfaces of the modular components are necessarily identical or mutually compatible. Beyond that, functional similarity of the modular components is not demanded. The modular components are, for instance, switching assemblies such as memory modules or interface modules.

The slots are usually formed as connectors fixed on a substrate, for instance a motherboard. The connectors additionally produce in each case an electrical connection between signal lines on the substrate and contact areas on the switching assemblies.

The connectors enable simple exchange or simple retrofitting of switching assemblies.

5 A typical example of such a modular system is a computer system (PC, workstation, server) with expandable main memory, slots for memory modules in the form of connectors being provided on the motherboard and being equipped with memory modules depending on the
10 desired size of the main memory.

With higher clock and data transfer rates to and from the memory modules, there is a rise in the requirements made of the design of the signal lines of the bus
15 system.

A bus system known as RAMBUS system provides, for example, shielded or differential bus signals which are looped through by the virtually series-connected
20 modules (up-down concept). With the RAMBUS system, substantially higher clock rates can be realized on the data bus at the expense of a significantly increased outlay on circuitry on the motherboard and the memory modules.

25 By contrast, a known type of DDRI system (double data rate) is a simple stub bus system with signal lines which are combined to form a main line and, proceeding from a bus control module on the motherboard, are
30 generally led through under the memory modules to a termination on the motherboard. The termination limits signal reflections. Stubs lead from the main line of the bus system to the connectors with the memory modules (stub bus).

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For higher clock rates, as are provided for DDRII systems, a termination is necessary at the end of each stub, that is to say at the bus control module and on each individual memory module, since, as the clock rate rises, the bus signals become more sensitive to reflections from a line end.

Generally, short signal lines, the lowest possible parasitic capacitances, inductances and resistances, and also the smallest possible number of reflection points in the course of the signal lines are necessary in order to ensure higher clock rates on the bus systems.

Therefore, there already exists (from the company FCI) a dual vertical DIMM connector having two receptacle devices (slots) for receiving 120-pole DIMMs. In this case, each contact element in the receptacle device is connected to a contact device on a mounting side of the connector. The contact devices on the mounting side of the connector are arranged as solder balls arranged offset in a grid structure (ball grid array). Combining two connectors to form a dual connector reduces the space requirement and increases the flexibility in routing the electrical connections on the main board.

The fashioning of the electrical signal lines between a bus control module, the connectors and possible terminations influences the signal quality on the signal lines and limits the maximum clock rate on the signal lines and thus the data transfer rate. Since it is foreseeable that both the computer system and the memory modules will need to be operated internally with higher data transfer rates, the maximum data transfer rate of the bus system itself increasingly limits the data transfer rate of a system.

Therefore, it is an object of the present invention to provide an arrangement which ensures a high data transfer rate to, from and between switching assemblies
5 mounted in connectors.

In the case of an arrangement of the type mentioned in the introduction, this object is achieved according to the invention by means of the features specified in the
10 characterizing part of patent claim 1. Advantageous developments of the invention emerge from the subclaims.

The connector according to the invention thus has
15 contact connections between contact elements of a plurality of receptacle devices (slots) of identical type. Switching assemblies of identical type which are provided in the receptacle devices are then not connected via contact connections on a substrate,
20 generally a main board, but rather by contact connections provided in or at an insulating body of the connector.

In this case the term switching assemblies of identical
25 type refers to those which have a compatible mechanical and electronic interface to the bus system. Switching assemblies of identical type can otherwise differ in multiple respects. If the switching assemblies are memory modules, then the latter may perfectly well have
30 a different internal construction, for instance with memory chips having a different memory size, but are equipped with a uniform interface for a common bus system (DDRI, DDRII, RAMBUS).

35 The signal lines of the bus system are led via contact devices of the connector according to the invention

from the substrate to corresponding contact elements of the receptacle devices, said contact elements being mechanically and electrically conductively connected to the contact devices.

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Compared with conventional connectors, the length of a signal path between corresponding contact elements of adjacent slots is reduced, as is the number of contact devices via which signals transferred on the signal paths are passed. The result is significantly reduced parasitic line capacitances, line resistances and line inductances (parasitics), and also, due to the reduced number of contact devices, a reduced number of reflection points.

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Since each soldering point in the bus system constitutes a potential fault source for an interruption of a signal line or for a short circuit of a signal line with an adjacent signal line, the frequency of faults is also reduced as a result of the greatly reduced number of soldering points. The number of contact areas or plated-through holes is correspondingly reduced on the substrate, so that the arrangement (routing) of electrical lines is facilitated there.

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The reduction of the line resistance of the signal lines or of the parasitic effects is beneficial particularly in a preferred embodiment of the invention, in which the contact connections are respectively arranged between the corresponding contact elements and connect the latter in the shortest way.

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In a series bus system, the bus signals of switching assemblies that are electrically connected in series are looped through from a first switching assembly in a

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first receptacle device to a last switching assembly or termination in a last receptacle device. In this case, the contact elements of a receptacle device are respectively assigned to an input set or an output set (up-down approach). The bus signals are then passed proceeding from the main board via the contact devices to the contact elements of the input set of the first receptacle device. On the switching assembly arranged in the receptacle device, the bus signals are possibly conditioned and passed to the contact elements of the output set. Via the contact connections, the contact elements of the output sets of the receptacle devices are respectively connected to the contact elements of the input sets of the respectively succeeding receptacle devices. An example of a series bus system for memory modules is the RAMBUS concept.

By contrast, the bus systems for DDRI and DDRII systems are in each case stub bus systems. Proceeding from a main line between a bus control module and an end point with a termination (DDRI) or last insertion location (DDRII), lines branch off to the individual insertion locations. In the case of a stub bus system, in the connector according to the invention, the contact connections are respectively arranged between the corresponding contact elements of at least a plurality, but preferably all, of the receptacle devices. In this case, the contact devices are provided at the contact elements of at least one receptacle device and are electrically conductively connected to said contact elements. The contact device and the contact element are then usually produced from one piece, for instance by stamping.

A stub bus system is realized in the connector in this case, the contact connections forming the main line. By

means of the contact devices, the stub bus system of the connector is connected to the signal lines on the main board.

5 In a preferred embodiment of the connector according to the invention, the contact devices are assigned to a single receptacle device. The contact elements of this one receptacle device are then mechanically and electrically conductively connected to the respectively
10 corresponding contact devices, and form a unit.

If required, for instance for DDRI systems, the termination of the stub bus system is also embodied in the connector. In this case, a termination is in each
15 case conductively connected to that end of the contact connections which is opposite to the feeding contact device.

In a particularly preferred embodiment of the connector
20 according to the invention, both a first and a last receptacle device are assigned contact devices to the substrate and the contact elements of the first and of the last receptacle device are provided with the respectively corresponding contact devices. As a
25 result, the stub bus system is led back to the substrate. The termination is then to be provided on the substrate.

In the case of a connector according to the invention
30 for a star bus system, the contact devices form a star point at an end oriented toward the contact elements, the contact connections from the contact elements of the receptacle devices also being led to said star point.

If the contact connections between the star point and the contact element are in each case formed essentially with the same length, then leads of identical length, and hence identical signal propagation times, advantageously result for all the receptacle devices connected to the star point. As a consequence, higher clock rates can be realized in such systems.

In a preferred embodiment, the connector according to the invention for star bus systems has two receptacle devices. In this case, the longitudinal axis of the contact elements and/or the contact connections between the star point and the contact elements are inclined by 45 to 75 degrees with respect to one another and with respect to the longitudinal axis of the contact device, in order to reduce signal reflections at the star point.

Preferably, the contact connections form an angle of essentially 60 degrees at the star point for two receptacle devices formed in the connector.

In a further preferred embodiment, the connector according to the invention has guides for the mechanical stabilization of switching assemblies which are arranged on expansion modules. These guides are embodied for instance in slot form in the insulating body or comprise a series of bulges on the insulating body which, as required, also have mechanical fixing or locking devices.

The terminations to be provided for a star bus system are advantageously arranged in or at the insulating body in each case in feeds to the star point, resulting in a particularly effective realization of the terminations. A symmetrical impedance, that is to say

an impedance that is independent of a signal direction, advantageously results in the event of an impedance matching at the star point of a star bus system.

5 In a stub bus system, the signal lines (transmission lines) brought together at a junction point (T point) in each case have an identical impedance of e.g. 50 ohms. At the T point, for signals brought to the T point on one signal line, a parallel circuit formed by
10 the other two signal lines with, in that case, an impedance of 25 ohms is effective in each case, which constitutes a mismatch and leads to reflections. A matching of the impedances at the T point is only ever possible in one direction of the signal transmission.

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In the case of a star bus system, a resistance of one third of the line impedance is preferably provided in or at the star point upstream of each signal line. In a 60 ohm environment, an impedance of 60 ohms is always
20 effective independently of the direction of a signal transmission at the star point. The impedance of 60 ohms always results from the addition of the resistance of 20 ohms in the signal-feeding line and a resistance of 40 ohms resulting, for its part, from the
25 parallel circuit comprising the impedances of the two outgoing signal lines, said impedances respectively being composed of a resistance of 20 ohms and the line impedance of 60 ohms, that is to say together 80 ohms. As a result of the direction-independent impedance
30 matching, the star bus system enables higher data transfer rates.

In this case, the terminations are preferably formed using thin-film technology.

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For all the bus systems mentioned, a particularly advantageous fashioning of the connector according to the invention results by virtue of an essentially parallel orientation of the receptacle devices, the receptacle devices in each case being arranged next to one another. In addition, each receptacle device has, as required, customary expert implementations such as coding devices, additional guiding and fixing elements or an ejection mechanism.

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A further preferred fashioning of the connector according to the invention results from the formation of the contact devices as solder balls for surface mounting, thereby minimizing parasitic effects of the contact devices and significantly simplifying the routing of lines on the main board.

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The invention is explained in more detail below with reference to figures, identical reference symbols being used for mutually corresponding components. In the figures:

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figure 1 shows a diagrammatic cross section through an arrangement with a connector according to the invention, according to a first exemplary embodiment of the invention for a stub bus system,

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figure 2 shows a diagrammatic cross section through an arrangement with conventional connectors for a stub bus system,

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figure 3 shows a diagrammatic cross section through an arrangement with a connector according to the invention, according to a second exemplary

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embodiment of the invention for a series bus system (up/down approach),

5 **figure 4** shows a diagrammatic cross section through a connector according to the invention, according to a third exemplary embodiment of the invention for a star bus system,

10 **figure 5** shows a perspective illustration of an arrangement comprising two contact elements and a contact connection provided between the contact elements according to the first exemplary embodiment of the connector according to the invention, and

15 **figure 6** shows a diagrammatic illustration of a contact pin according to the third exemplary embodiment of the connector according to the invention.

20 Figures 1 to 4 relate to PC systems whose main memory can be configured by the provision of insertion locations on a main board as slots for memory modules. However, a multiplicity of other designs of the
25 connector according to the invention are obvious to the person skilled in the art.

30 In accordance with the conventional arrangement illustrated in figure 2, a bus control module 31, a plurality of connectors 1, and also terminations 11 are arranged on a main board as substrate 3. The bus control module 31, the connectors 1 and also the terminations 11 are electrically conductively connected to one another via the signal lines 32 of a stub bus
35 system. The connectors 1 respectively have a receptacle device 5, at whose inner areas 9 contact elements 7 are

provided. The contact elements 7 are connected in each case to a corresponding contact device 8, which are formed as contact pins in this example. The two right-hand connectors 1 are equipped with switching assemblies 2 having contact areas 6. In the equipped state, in which a switching assembly 2 is arranged in one of the receptacle devices 5, the contact areas 6 are opposite the contact elements 7.

Each of the units formed from in each case one of the contact devices 8 and one of the contact elements 7 constitutes a conductive stub from the main line of the bus system formed by the signal lines 32, which stub has parasitic properties in each case proportional to the total length of the stub. In this respect, the length of the stub determines, by way of the propagation time, a delay of a reflected interference signal relative to a undelayed useful signal.

By contrast, the functionally comparable arrangement illustrated in figure 1 with a connector 1 according to the invention has contact connections 10 provided in the insulating body 4 of the connector 1, said contact connections connecting respectively corresponding contact elements 7 of the receptacle devices 51, 52, 53 and 54 to one another. Both the contact elements 7 of a first 51 and of a last 54 receptacle device are assigned contact devices 8 for the electrical contact-making of the signal lines 32 arranged in or on the substrate 3. The contact elements 7 of the first 51 and of the last 54 receptacle device form a unit together with the contact devices 8.

The signal lines of the stub bus system are thus integrated into the connector 1 in the form of the contact connections 10. The length of the stubs and

thus the effect of reflections is reduced. The length of signal paths between the switching assemblies 2 and thus the signal propagation time differences between the individual switching assemblies 2 are likewise reduced. The probability of defective connections between the connector 1 and the substrate 3 is reduced by virtue of the reduced number of soldering points required between the substrate 3 and the receptacle devices 5. On the substrate 3, there remains significantly more space for electrical lines below the connector 1, thereby facilitating the arrangement of lines on the substrate 3.

In figure 3, the bus control module 31 and the switching assemblies 2 are connected via a series bus system (up/down approach). The contact connections 10 in each case connect only two contact elements 7, in each case one contact element 7 being assigned to an output set 72 of contact elements 7 of a receptacle device 51, 52, 53, 54 and the other contact element 7 being assigned to an input set 71 of a succeeding receptacle device 52, 53, 54, 55. The series bus system requires a termination module 21 in the respectively last equipped receptacle device 54.

A connector according to the invention for a star bus system is illustrated in cross section in figure 4a and in plan view in figure 4b. In this case, an insulating body 4 has contact devices 8 at a surface facing the substrate 3. The receptacle devices 51, 52 are of slot-like design and inclined by about 60 degrees with respect to one another and with respect to a surface of the main board. A contact device 8, two corresponding contact elements 7, and a contact connection 10 in each case form a contact pin 13. An identical connection length between a star point 12 and a contact region 70

on the two corresponding contact elements 7 advantageously results for each contact pin 13. Furthermore, symmetrical attenuation properties and reflection points that are independent of a signal direction of a signal are present in each case. This means that, for all the bus signals, identical signal propagation times from and to a bus control module result for switching assemblies 2 arranged in the receptacle devices 51, 52, thereby enabling an increased clock rate compared with conventional connectors.

Moreover, the insulating body 4 has stabilization devices 15 for the mechanical stabilization of switching assemblies 2 arranged on expansion modules.

Further cutouts 16 on a mounting area facing the substrate 3 enable the arrangement of terminations 11 on the substrate 3 in the region below the connector 1.

Figure 5 illustrates two pairs of contact elements 7, 7' respectively connected by means of a contact connection 10. In this case, the contact elements 7, 7' respectively assigned to a common receptacle device 5 are opposite one another in an offset manner at the receptacle devices 5.

Figure 6a illustrates a contact pin 13 for a star bus system with its functional sections of contact device 8, contact elements 7 with contact regions 70, contact connection 10 and star point 12 in a first embodiment. In this case, the contact pin 13 can be produced in one piece by customary means, for instance stamping.

A second embodiment of the contact pin 13 is shown in figure 6b. In this case, the star point 12 is formed as

an auxiliary substrate 14. The auxiliary substrate 14, which in this case is oriented parallel to the substrate 3, may also be arranged perpendicular to the latter. Terminations (star resistors) are provided on
5 or in the auxiliary substrate 14. If the auxiliary substrate 14 is formed as a ceramic substrate, then the terminations are realized using thick-film technology. If the auxiliary substrate 14 is formed as a circuit board (PCB), then the terminations are formed as SMD
10 (surface mounted devices) or as buried resistors.

List of reference symbols

1	Connector
10	Contact connection
11	Termination
12	Star point
13	Contact pin
14	Auxiliary substrate
15	Stabilization device
16	Cutout
2	Switching assembly
21	Termination switching group
3	Substrate
31	Bus control module
32, 32'	Signal line
4	Insulating body
5	Individual receptacle device
51	First receptacle device
52, 53	Receptacle device
54	Last receptacle device
6	Contact area
7, 7'	Contact element
70	Contact region
71	Input set
72	Output set
8	Contact device
9	Inner area

Claims

1. A connector for the fixing and contact-making of switching assemblies having contact areas and mutually compatible interfaces on a substrates,

5 comprising

- an insulating body,
- a plurality of receptacle devices formed in the insulating body and serving for the arrangement of switching assemblies,
- contact elements arranged at inner areas of the receptacle devices and opposite the respectively corresponding contact areas on the switching assemblies,
- contact devices for the electrical contact-making of signal lines arranged on or in the substrate, and
- contact connections formed in or at the insulating body and electrically
- 15 conductively connecting respectively corresponding contact elements of at least two receptacle devices to one another,

characterized in that

- the contact devices are provided at the contact elements of precisely one receptacle device,
- 20 - at least one termination conductively connected to one of the contact connections is arranged in or at the insulating body, and so

the signal lines can be at least partly terminated by means of the connector.

2. The connector as claimed in claim 1,

characterized in that

the contact connections are formed straight and arranged parallel to the surface of the substrate.

3. The connector as claimed in either of claims 1 and 2, characterized in that

- 5 - the contact elements of a receptacle device are respectively assigned to an input set of signal-feeding contact elements or to an output set of signal-outputting contact elements,
- the contact devices are provided at the respectively corresponding contact elements of the input set of a first receptacle device and are electrically connected to said contact elements,
- 10 - the contact connections are respectively arranged between the corresponding contact elements of the output set of one of the receptacle devices and of the input set of a respectively succeeding receptacle device, and so
- 15 the switching assemblies can be electrically connected in series.

4. The connector as claimed in either of claims 1 or 2, characterized in that

- the contact connections are formed between the respectively corresponding contact elements of at least a plurality of receptacle devices,
- 20 - the contact devices are provided at the contact elements of at least one receptacle device, and so
- the switching assemblies can be electrically connected in parallel.

5. The connector as claimed in claim 4,

characterized in that

the contact devices are respectively arranged at the contact elements of the first and of a last receptacle device and the signal lines can be terminated on a substrate.

5 6. The connector as claimed in claim 1,

characterized in that

the contact devices respectively have a star point and the contact connections to the corresponding contact elements are respectively led to the star point.

7. The connector as claimed in claim 6,

10 characterized in that

the length of the contact connections between the star point and the corresponding contact elements of the assigned receptacle devices is essentially identical.

8. The connector as claimed in one of claims 6 to 7,

15 characterized in that

the contact elements and/or the contact connections, between the star point and the contact elements are offset essentially between 45 and 75 degrees with respect to one another and with respect to the orientation of the contact devices.

20 9. The connector as claimed in one of claims 6 to 8,

characterized in that

terminations (are arranged in the insulating body in each case between the star point and the contact device and the star point and the contact connections.

10. The connector as claimed in one of claims 6 to 9,

characterized in that

the terminations are formed using thin-film technology.

11. The connector as claimed in one of claims 1 to 10,

characterized in that

5 the receptacle devices are arranged next to one another and oriented in a parallel manner.

12. The connector as claimed in one of claims 1 to 11,

characterized in that

the contact devices are formed as solder balls for surface mounting.

10 13. The connector as claimed in one of claims 1 to 12,

characterized in that

the receptacle devices are arranged next to one another and oriented in a parallel manner in a plane parallel to a mounting surface of the substrate.

14. A connector for the fixing and contact-making of switching assemblies

15 having contact areas and mutually compatible interfaces on a substrate, comprising

- an insulating body,
- a plurality of receptacle devices formed in the insulating body and serving for the arrangement of switching assemblies,
- 20 - contact elements arranged at inner areas of the receptacle devices and opposite the respectively corresponding contact areas on the switching assemblies, and
- contact devices for the electrical contact-making of signal lines arranged on or in the substrate, and

- contact connections formed in or at the insulating body and electrically conductively connecting respectively corresponding contact elements of at least two receptacle devices for switching assemblies that can be electrically connected in parallel to one another,
- 5 characterized in that
- the contact devices respectively have a star point and the contact connections to the corresponding contact elements are respectively led to the star point.