

the joint inv. etc.

9604031-6
IPDS

DUPLICATE

THIS SHEET HAS BEEN
REPLACED

- 1 -

ELECTRICAL CONNECTORS

5 This invention relates to a connection device that provides any form of electrical connection between two discrete electrical cables or alternatively an electrical cable terminated by a plug and electrically insulated wires. It has application, for example, in data or telecommunications where a computer terminal
10 or telephone instrument is connected by a lead with an appropriate plug to a jack provided in a wall panel. The jack requires connection to data or telephone cables on the opposite side of the wall panel.

15 Arrangements are known in which a jack is provided on a wall panel the jack being connected by way of a printed circuit board to terminal elements which can be connected to the telephone wires. Such arrangements are not easily assembled nor are they
20 easily changed when faulty.

An improvement over this type of arrangement is described in GB-A-2242080. This connector has a moulded housing with a cavity for receiving the plug,

This Sheet Has Been Replaced.



THIS SHEET HAS BEEN
REPLACED

- 2 -

5 a first set of connecting elements which can receive insulated wire and make electrical contact with the electrically conductive core and a second set of contacts which are connected to the first set and extend from the first set to the cavity such that they can come into electrical contact with contacts carried by the plug. The second set of contacts for part of their extent are located in longitudinal closely spaced relationship.

10

In data communication systems connectors of this type operate satisfactorily at low or moderate data rates. As data rates increase however the system connectors exhibit an impedance imbalance which limits the performance of the system. This impedance imbalance is usually measured as near end crosstalk between recognised pairs. Attempts have been made to alleviate this problem by screening or by reduction in the size of the contact elements. These approaches are not entirely satisfactory and the present invention is concerned with an alternative solutions.

15

20

This Sheet Has Been Replaced



- 3 -

The present solution arises partly from a careful analysis of the origin of crosstalk in a connector of a type described in GB-A-2242080. Our analysis in which the pairs of contacts are considered as forming a bridge network shows that the major source of crosstalk arises from capacitative imbalance between the pairs.

The following simple mathematical model indentifies the problem to be solved. A connector of the type described in GB-A-2242080. is an 8 wire/4 pair connector. There exist several recognised wiring/pair configurations for this connector, but for simplification and clarification only one of these will be considered in the following analysis.

It is usual to number the contacts on the connector from 1 to 8. The recognised wiring/pair configurations are defined as follows:

20

Wires/Contacts	Recognised pair configuration
1 & 2	Pair 2
3 & 6	Pair 3

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

- 4 -

5 & 4

Pair 1

7 & 8

Pair 4

5 The equivalent circuit for say pairs 1 & 3 is shown in
Figure 2 of the drawings. In this Figure C_1 is the
capacitance between contacts 3 and 5, C_2 is the
capacitance between contacts 3 and 4, C_3 the
capacitance between contacts 5 and 6, and C_4 the
capacitance between contacts 6 and 4. R_l is the line
10 impedance.

This equivalent circuit needs to be considered as it
relates to both the connector and its mating plug,
which is shown schematically in Figure 3 of the
15 drawings. For simplicity this Figure shows
schematically just the plug and connector. In the
arrangement the 8 plug contacts are shown at 120 and
make contact with the connecting elements 93 in a
socket of the connector shown at 50. The elements 93
20 extend along parallel paths to IDC contacts 80.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

- 5 -

Considering Figure 3 and the bridge of Figure 2 it will be appreciated that if one assumes C_1 is unity then

5 $C_1 = 1$

$$C_2 = 2$$

$$C_3 = 2$$

$$C_4 = 1$$

10 For no crosstalk there must be no current flow through R. For this to happen the bridge must be balanced, that is to say

15
$$\frac{C_1}{C_2} = \frac{C_3}{C_4}$$

However for the capacitance values given above the relationship in fact gives

20
$$\frac{1}{2} = \frac{2}{1}$$

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

- 6 -

Clearly the bridge is unbalanced and this leads to crosstalk. A similar situation exists in connection with pairs 2 and 3 and also between pairs 3 and 4, although the capacitive imbalance is not so significant for these pair configurations with this connector.

As a result of this analysis we have discovered two ways of minimising crosstalk.

10

The first is to configure the contacts of a connector of the type referred to above in such a way that the capacitative imbalance is reduced.

15

The second is to provide elements in association with said contacts which provide a controlled capacitance such as to reduce said imbalance. Any other function which the element has will be secondary to this prime function.

20

In both of the above examples the contact arrangements can be organised to balance not only the inherent capacitive imbalance of the said connector, but also

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

- 7 -

to compensate for the inherent capacitive imbalance of
any associated appropriate plug.

5 The said contact arrangements can also be organised
to compensate for any capacitive imbalance effects
introduced by the wiring practices associated with the
connector or the plug.

10 The invention will be described from now by way of
example only with particular reference to the
accompanying drawings.

In the drawings:

15 Figure 1 is an exploded view of a connector
described in GB-A-2242080;

20 Figure 2 is an equivalent circuit diagram for
two contact pairs of the connector of
Figure 1;

Figure 3 is a schematic view of the
interconnecting arrangement provided by
the connector of Figure 1;

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

- 8 -

Figure 4 is a perspective view illustrating a connector in accordance with the present invention,

5 Figure 5 is a schematic view of an interconnecting arrangement provided by a connector in accordance with the present invention;

10 Figure 6 is a view similar to figure 2 of an alternative form of connector in accordance with the present invention, and

15 Figure 7 shows a modified form of lead frame which uses controlled capacitance to balance the connector.

20 Figure 1 shows a connector which is described in detail in GB-A-2242080. In brief it comprises a moulded housing having a moulded upper body part 10 and a lower moulded body part 11. The body parts when connected together define a cavity 50 into which can be located a plug such as that formed on the end of a

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

- 9 -

5 cable extending from a telephone instrument or a
terminal of the type used in computing equipment. The
housing includes a first set of contact elements 80
which extend upwardly and terminate in slots which can
receive insulated wire in such a way that the walls of
the slots cut the insulation and thereby make contact
with the electrically connected core. The contacts 80
are connected to a second set of contacts which
include elongate strips 93 which extend along grooves
10 26 formed in the moulded upper body part and which in
the assembled body terminate in the cavity 50 in such
a way that they can contact electrical contacts
carried by the plug. It will be seen that the strips
93 extend in longitudinally closely spaced, parallel
15 relationship from the contact elements 80 to the
cavity 50.

Our analysis of this arrangement has revealed that
this type of configuration has an inherent
20 capacitative imbalance which gives unacceptable
crosstalk levels at high data rates.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

- 10 -

One embodiment of the present invention which alleviates this problem is that illustrated in Figure 4 of the drawings. It will be seen from Figure 4 that the connector is of the same general form as that shown in Figure 1 and that the strips 93 are configured so that they do not lie in parallel paths but are configured to extend along more tortuous paths from the cavity 50 to the connecting elements 80. Additionally the contact positions are re-arranged from their convention positions.

The effect of this arrangement can be best understood by considering the schematic of Figure 5 of the drawings in conjunction with the existing arrangement of Figure 3 and the bridge arrangement of Figure 2. The analysis of Figure 3 showed that the bridge arrangement was unbalanced. We have found that this imbalance can be overcome by carefully positioning the connecting elements 93 to compensate for the inherent capacitive imbalance of the plug and connecting wire. Figure 5 shows one possible arrangement whereby re-arranging the contact positions and their physical relationship to each other makes it possible to reduce the capacitive imbalance.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

- 11 -

In the arrangement of Figure 5 this is achieved by increasing C_1 and C_4 (see discussion relating to Figure 2 above) and by positioning the contact elements 3 and 5 closer together and also the contact elements 4 and 6 closer together. The net effect of this re-arrangement is to lead to a balancing of the capacitance so that, for example with reference to Figure 2

$$\frac{C_1}{C_2} = \frac{C_3}{C_4}$$

It is also possible to decrease C_2 and C_3 by positioning contact elements 3 and 4 further apart and contact elements 5 and 6 further apart. Similarly the electrical performance of the other pair of configurations can be improved in a similar manner. Hence the connector shown in figure 2 of the drawings is capable of meeting the requirements for high data rate communication systems.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

- 12 -

An alternative arrangement of the present invention is shown in figure 6 of the drawings. The male housing part, indicated generally at 100 in Figure 1, is not shown in Figure 6, though it will be understood that it will slide into groove 30 and snap into window 16 as in the first arrangement. In the arrangement of figure 2 of the drawings the order in which the contact 80 are connected to the strips 193 is maintained the same as that for GB-A-2242080.

Figure 7 shows a modified form of the leadframe (90/92 Figure 1). Electrically connected to this leadframe is a second contact element. The second contact element could be either a flexible printed circuit board or a metallic element where the element is insulated with a high dielectric material. This high dielectric material is positioned on the contact element in specific areas to provide controlled capacitive to the other contact positions to balance out the inherent capacitive imbalance.

This Sheet Has Been Replaced





THIS SHEET HAS BEEN
REPLACED

- 13 -

CLAIMS:

1. A connector for providing a connection between two electrical cables each of which includes a plurality of conductive wires, said connector including means enabling contact to be established with the wires of each of the cables and a plurality of conductive elements extending between the contact enabling means, said conductive elements being so arranged and configured so as to minimise capacitive imbalance between the pairs of contacts.

2. A connector according to claim 1, wherein the capacitive imbalance is minimised by appropriately configuring the path along which the conductive elements extend.

3. A connector according to claim 1 or claim 2, wherein the capacitive imbalance is minimised by selection of the interconnection arrangement of the contacts of the contact enabling means by the connecting elements.

This Sheet Has Been Replaced





THIS SHEET HAS BEEN
REPLACED

- 14 -

4. A connector according to any preceding claim, wherein at least one of the contact enabling means is a socket for receiving a plug on the end of a cable.

5

5. A connector according to any preceding claim, wherein at least one of the contact enabling means is a plurality of insulation displacement type contacts.

10

6. A connector according to any preceding claim, wherein the connector is of the general type described in GB-A-2242080.

15

7. A connector for providing a connection between two electrical cables, each of which includes a plurality of conductive wires, said connector including means enabling contact to be established with the wires of each of the cables and a plurality of conductive elements extending between the contact enabling means, and wherein an element or elements is provided in association with one or more of the contacts of the contact enabling means to provide a

20

This Sheet Has Been Replaced





THIS SHEET HAS BEEN
REPLACED

- 15 -

controlled capacitance such as to minimise capacitive
imbalance between pairs of contacts.

8. A connector for providing a connection
5 between two electrical cables substantially as
hereinbefore described with reference to and as shown
in the accompanying drawings.

This Sheet Has Been Replaced

