(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
5 January 2006 (05.01.2006)

PCT

(10) International Publication Number
WO 2006/000522 A1

(51) International Patent Classification[7]: H01R 13/648

(21) International Application Number:
PCT/EP2005/052601

(22) International Filing Date: 7 June 2005 (07.06.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0414007.5 23 June 2004 (23.06.2004) GB

(71) Applicant *(for all designated States except US)*: **INTERNATIONAL BUSINESS MACHINES CORPORATION** [US/US]; New Orchard Road, Armonk, NY 10504 (US).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **MASON, James, Stephen** [GB/GB]; 1 Royston Avenue, Eastleigh Hampshire SO50 4NH (GB).

(74) Agent: **LING, Christopher, John**; IBM United Kingdom Limited, Intellectual Property Law, Hursley Park, Winchester Hampshire SO21 2JN (GB).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

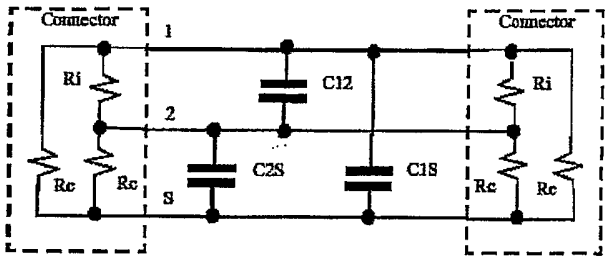
(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

WO 2006/000522 A1

(54) Title: A CONNECTOR



(57) Abstract: A connector for use with a cable having components susceptible to triboelectrically-induced intercomponent charge comprises a signal component; a compensating resistive network to substantially equilibrate a plurality of triboelectrically-induced charges across the components; and a ground connect component for connecting the connector to ground prior to connection of the signal component. A process for manufacturing a connector for use with a cable having components susceptible to triboelectrically-induced intercomponent charge and comprises steps of: providing a signal component; providing a compensating resistive network to substantially equilibrate a plurality of triboelectrically-induced charges across the components; and providing a ground connect component for connecting the connector to ground prior to connection of the signal component.

Description

A CONNECTOR

Technical Field

[001] The present invention relates to cable and connector assemblies, and more particularly to cable and connector assemblies used for high-frequency transmission lines.

Background Art

[002] The triboelectric effect is an electrical phenomenon in which certain materials can become electrically charged by friction or being rubbed against another material. In the context of electrical cables, it is well known that cables can become charged as they are handled and that this can cause significant charge differentials to be induced across the interconductor capacitances. Due to the low leakage of modern cables, charge can remain on the conductors until the cable is plugged into the associated equipment, whereupon the high voltage can cause serious damage to the interface electronics unless sufficient transient protection is provided. This effect is also occasionally termed 'cable static' and presents a general problem by providing a source of static electrical charge which can cause significant damage to electronic equipment. The use of integrated electronics and high speeds of operation in modern communications systems makes this problem more serious as the smaller feature size of the active devices connected to the line make them more susceptible to transient damage and the high frequency of operation make the inclusion of protection networks more difficult.

[003] A typical modern datacommunications cable comprises 4 wires which make up two differential pairs formed by the white-blue and red-green wires. Another well-known data-carrying cable is the flat ribbon cable typically used, for example, to connect motherboards to hard disk drives. Each of the wires in such cables has a mutual capacitance to each other wire and also down to the cable shield. As the cable is moved across another material, all of these capacitances can become triboelectrically charged with intercomponent charge differentials. Due to the very low leakage associated with these capacitances the discharge time can be long enough such that significant intercomponent charge differentials remain when the signal-bearing components of the cable are plugged into equipment.

[004] It would thus be desirable to alleviate the aforementioned disadvantageous potential for large differential charges being discharged into sensitive devices.

Disclosure of Invention

[005] In a first aspect, the present invention provides a connector for use with a cable having components susceptible to triboelectrically-induced intercomponent charge and comprising: a signal component; a compensating resistive network to substantially

equilibrate a plurality of triboelectrically-induced charges across said components; and a ground connect component for connecting said connector to ground prior to connection of the signal component.

[006] Preferably, said compensating resistive network comprises a discrete component in said connector.

[007] Preferably, said discrete component is mounted on a PCB.

[008] Preferably, said compensating resistive network comprises an integrated component in said connector.

[009] Preferably, said integrated component is mounted on a PCB.

[010] Preferably, said compensating resistive network comprises a conductive material used as a header in said connector.

[011] Preferably, the ground connect component is of greater length than the signal component.

[012] There is preferably provided a cable assembly comprising a cable and attached thereto a connector according to the first aspect of the present invention.

[013] In a second aspect, the present invention provides a process for manufacturing a connector for use with a cable having components susceptible to triboelectrically-induced intercomponent charge and comprising steps of: providing a signal component; providing a compensating resistive network to substantially equilibrate a plurality of triboelectrically-induced charges across said components; and providing a ground connect component for connecting said connector to ground prior to connection of the signal component.

[014] Preferably, said compensating resistive network comprises a discrete component in one or more of said connectors.

[015] Preferably, said discrete component is mounted on a PCB.

[016] Preferably, said compensating resistive network comprises an integrated component in one or more of said connectors.

[017] Preferably, said integrated component is mounted on a PCB.

[018] Preferably, said compensating resistive network comprises a conductive material used as a header in one or more of said connectors.

[019] Preferably, the ground connect component is made to be of greater length than the signal component.

[020] There is preferably provided a process for manufacturing a cable assembly comprising steps of: providing a cable; and providing a connector produced by a process according to the second aspect of the present invention.

Brief Description of the Drawings

[021] A preferred embodiment of the present invention will now be described, by way of

example only, with reference to the accompanying drawing figures, in which:

[022] Figure 1 illustrates the interconductor capacitances for a single differential pair in a cable.

[023] Figure 2 illustrates the insertion of discharge resistors at the cable connectors according to one possible embodiment of the present invention.

[024] Figure 3 shows in schematic form a cable connected to a connector according to a preferred embodiment of the present invention.

Best Mode for Carrying Out the Invention

[025] Preferred embodiments of the present invention address the problem of tribo-electrically-induced intercomponent capacitance discharge for the transmission line case where the characteristic impedance of the line is typically only several hundred ohms at most. In this case, it is possible to introduce a parallel discharge path to the interconductor capacitances which is much higher than the characteristic impedance. This discharge network can thus have a negligible effect on the line performance.

[026] In preferred embodiments of the present invention, there is provided a discharge path within the cable assembly itself such that any induced charge differentials can be equilibrated before the signal components of the cable are connected to equipment. The charge can then be conducted to ground, as is well known, by means of a ground connector that connects prior to the connection of any signal pins. It is well known that increasing the loss of the cable would be detrimental to its overall performance. However, a parallel resistance which connects across each cable capacitance at each connector could be arranged to have a much lower effect on the performance of the cable/connector system. Moreover this resistance could be conveniently implemented at low cost by introducing a resistive component to the material which conventionally provides the insulating support between the pins of the connector.

[027] The electrical representation of the interconductor capacitances of one pair within such a cable is shown in Figure 1. The capacitance between the wires (marked 1 and 2) in the differential pair is represented by C12 and that between each wire and the shield (denoted by S) by C1S and C2S. If the cable is operating as a transmission line then the termination impedances will be close to the characteristic impedance of the cable which is typically in the 30 to 300 ohm range. Consequently it is possible to place resistances in parallel with the cable capacitances of Figure 2 such that they have a negligible effect on the termination impedance but provide a discharge path for any triboelectrically induced charge differentials; this is shown in Figure 2. As an example, if this discharge resistance is 1000x the termination impedance it would typically have a value of several hundred kilohms.

[028] Turning to Figure 3, there is shown in schematic form a cable 302, together with

connector 300, forming one end of a cable and connector assembly according to a preferred embodiment of the invention. In connector 300 is compensating resistive network 304. Compensating resistive network 304 substantially equilibrates tribo-electrically-induced charges across the components. Also shown are a ground connect component 306 and a signal component 308. The ground connect component 306 is selected to connect the connector 300 to ground prior to the connection of signal component 308. Clearly, this may be done simply by, for example, making ground connect component 306 longer than signal component 308.

[029] The discharge resistance network could be built using discrete components within the connector. However a lower cost and more convenient method would be to make the part of the connector which houses the individual pins conductive. In a conventional DB9 connector, for example, which represents a typical connector used in this application, a plastic moulding, known here as a header, is used to mechanically support and isolate the signal pins. It is possible to increase the conductivity of such a plastic material, for example by loading the moulding material with conductive particles. In this way the header could be made sufficiently resistive such that suitable discharge resistance paths existed between the signal pins and shield connections. The geometric design of the header would place constraints on the ratios of the various discharge resistance paths but as has been previously seen, this application would accept a large tolerance on these resistor values.

[030] Another typical connector, well known to the person of ordinary skill in the art, is the HSSDC connector, where a single row of contacts is mounted on a pin support and insulator. As before, this pin support could be made resistive by making the moulding from a material with the appropriate level of conductivity. Alternatively some connectors are able to house an internal printed circuit board (PCB). An appropriate discharge network could be mounted on this PCB from either discrete or integrated components. Such a solution is likely to be more costly but more accurate then the use of conductive materials in the connector header.

[031] Described here are preferred embodiments of the present invention, and it will be clear to one of ordinary skill in the art that there may be many modifications still falling within the scope of the present invention.

Claims

[001] 1. A connector for use with a cable having components susceptible to tribo-electrically-induced intercomponent charge and comprising: a signal component; a compensating resistive network to substantially equilibrate a plurality of tribo-electrically-induced charges across said components; and a ground connect component for connecting said connector to ground prior to connection of the signal component.

[002] 2. The connector as claimed in claim, wherein said compensating resistive network comprises a discrete component in said connector.

[003] 3. The connector as claimed in claim 2, wherein said discrete component is mounted on a PCB.

[004] 4. The connector as claimed in claim 1, wherein said compensating resistive network comprises an integrated component in said connector.

[005] 5. The connector as claimed in claim 4, wherein said integrated component is mounted on a PCB.

[006] 6. The connector as claimed in claim 1, wherein said compensating resistive network comprises a conductive material used as a header in said connector.

[007] 7. The connector as claimed in any preceding claim, wherein the ground connect component is of greater length than the signal component.

[008] 8. A cable assembly comprising a cable and attached thereto a connector as claimed in any preceding claim.

[009] 9. A process for manufacturing a connector for use with a cable having components susceptible to triboelectrically-induced intercomponent charge and comprising steps of: providing a signal component; providing a compensating resistive network to substantially equilibrate a plurality of triboelectrically-induced charges across said components; and providing a ground connect component for connecting said connector to ground prior to connection of the signal component.

[010] 10. The process as claimed in claim 9, wherein said compensating resistive network comprises a discrete component in one or more of said connectors.

[011] 11. The process as claimed in claim 10, wherein said discrete component is mounted on a PCB.

[012] 12. The process as claimed in claim 9, wherein said compensating resistive network comprises an integrated component in one or more of said connectors.

[013] 13. The process as claimed in claim 12, wherein said integrated component is mounted on a PCB.

[014] 14. The process as claimed in 9, wherein said compensating resistive network

comprises a conductive material used as a header in one or more of said connectors.

[015] 15. The process as claimed in any of claims 9 to 14, wherein the ground connect component is made to be of greater length than the signal component.

[016] 16. A process for manufacturing a cable assembly comprising steps of: providing a cable; and providing a connector produced by a process according to any of claims 9 to 15.

[Fig.]

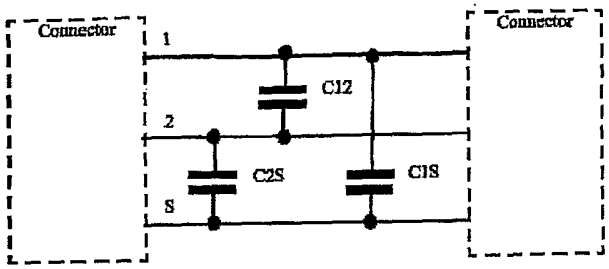


Figure 1

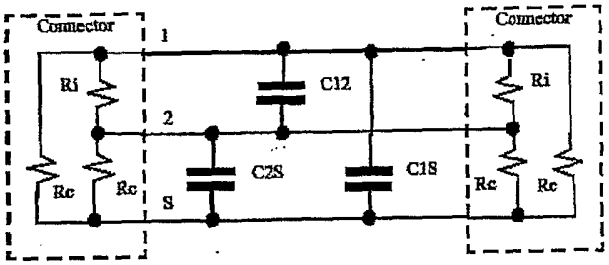


Figure 2

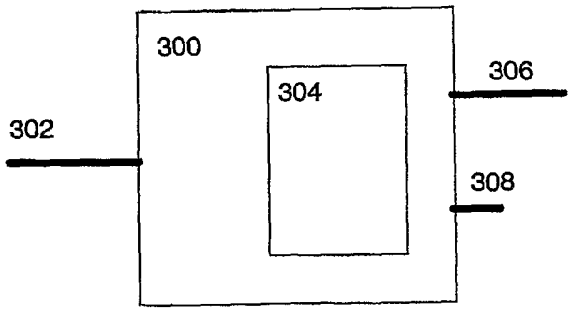


Figure 3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2005/052601

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01R13/648

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01R G01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	US 6 790 097 B1 (EDWARDS JAMES W ET AL) 14 September 2004 (2004-09-14) column 3, line 43 - line 62; figures 1-7	1-16
X Y	US 2003/011375 A1 (DELEU EDWARD W ET AL) 16 January 2003 (2003-01-16) column 2, paragraphs 17,18; figures 1-4	1,4,6-9, 12,14-16 2,10
X	US 6 468 097 B1 (BERNSTEIN ELLIOT ET AL) 22 October 2002 (2002-10-22) column 4, line 5 - line 8; figure 3	1,2,4, 8-10,12, 16
Y	US 2002/151201 A1 (BOHBOT MICHEL) 17 October 2002 (2002-10-17) page 4, paragraph 41; figures 1-14	2,10

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 September 2005	08/11/2005

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Tappeiner, R

Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2005/052601

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2003/070026 A1 (SIDES CHI KIM ET AL) 10 April 2003 (2003-04-10) abstract; figure 2	1
A	EP 0 414 467 A (MINNESOTA MINING AND MANUFACTURING COMPANY) 27 February 1991 (1991-02-27) page 5, line 40 - line 42; figures 1-7	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP2005/052601

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6790097 B1	14-09-2004	NONE	
US 2003011375 A1	16-01-2003	NONE	
US 6468097 B1	22-10-2002	NONE	
US 2002151201 A1	17-10-2002	NONE	
US 2003070026 A1	10-04-2003	NONE	
EP 0414467 A	27-02-1991	AT 132379 T	15-01-1996
		CA 2021287 A1	24-02-1991
		DE 69024562 D1	15-02-1996
		DE 69024562 T2	19-09-1996
		HK 1007695 A1	23-04-1999
		JP 2528794 Y2	12-03-1997
		JP 3076398 U	31-07-1991
		SG 73412 A1	20-06-2000
		US 5018044 A	21-05-1991