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ELECTRICAL ISOLATOR

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FIELD OF THE INVENTION

5 The present invention relates to an electrical isolator, which is specially adapted to protect an electronic device from Electromagnetic Interference (EMI) and conducted electrical noise in external wiring.

10 BACKGROUND OF INVENTION

 The exposure of electronic devices to Electromagnetic Interference (EMI) is undesirable and can adversely affect their performance. One method of reducing
15 the amount of EMI exposure is to place electronic devices within housings that function as electromagnetic shields. Coaxial cable wiring is used for carrying signals in sensitive electronic systems to further reduce noise.

20 Coaxial cables have an inner and outer conductor separated by electrical insulating material, and are generally circular in cross section. The inner conductor carries the electrical signal whereas the outer conductor provides the return path and is typically grounded. The
25 outer conductor completely surrounds the inner conductor thereby shielding it from EMI. The outer conductor, however, is susceptible to conducted EMI whereby electromagnetic waves in free space are converted to circuit currents which contribute to the amount of
30 electrical noise in the system.

 Electrically connecting the outer conductor of the coaxial cable to the device housing, thereby grounding the housing, serves to reduce the noise entering the
35 housing in the outer conductor. Alternatively, coupling the outer conductor to the device housing with a capacitor has the added benefit of blocking DC voltage thereby

providing protection against lighting strikes. Devices having such arrangements are termed electrical isolators.

We have previously proposed the electrical
5 isolator, disclosed in Chinese patent ZL 96,122,929.2. The
electrical isolator disclosed in this patent has a
housing coupled to the outer conductor of a connector by
capacitors. The connector has an analogous structure to
coaxial cable: that is there is provided an outer
10 conductor and an inner conductor separated by insulation
material. The electronic device to be protected is located
within the housing.

The connector extends through an aperture in the
15 housing and has a termination which can be connected to
coaxial cable on the outside of the housing. The connector
is positioned within the aperture by a plastic spacer
which fills the gap between the connector and the housing.

20 The foregoing electrical isolator is effective
for attenuating conducted electrical noise entering the
housing in the outer conductor of the connector, however,
it has a drawback whereby EMI freely enters the housing
through the plastic spacer. Accordingly, there is a need
25 for an electrical isolator which further reduces the
amount of EMI entering the housing.

SUMMARY OF INVENTION

According to the present invention, there is provided
5 an electrical isolator for protecting at least one
electronic device, said isolator having:

a housing which functions as an electromagnetic
shield;

a connector extending through an aperture in said
10 housing, said connector having an inner conductor and an
outer conductor separated by electrical insulator
material, said inner conductor and said outer conductor
being electrically connected to said at least one
electronic device in use; and

15 a first ferrite spacer which surrounds said connector
and plugs a gap between said connector and said housing,
whereby said first ferrite spacer impedes electromagnetic
interference (EMI) from entering said housing through said
gap.

20 Preferably, said housing is an electrical conductor
and said electrical isolator further comprises a first
capacitor which electrically couples said housing to said
outer conductor, said first ferrite spacer introducing a
first impedance in said outer conductor, and said first
25 capacitor combines with said first impedance and said
housing to form an electrical network for attenuating
electrical noise entering said housing in said outer
conductor.

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BRIEF DESCRIPTION OF DRAWINGS

A preferred embodiment of the invention will now
be described in relation to the accompanying drawings in
35 which:

Figure 1 is a cross sectional view of an electrical

isolator according to a first embodiment of the present invention;

Figure 2 shows an equivalent electrical circuit of the electrical isolator of Figure 1;

5 Figure 3 shows an equivalent electrical circuit of an electrical isolator according to a second embodiment of the present invention; and

Figure 4 shows an equivalent electrical circuit of an electrical isolator according to a third embodiment of the
10 present invention.

DESCRIPTION OF PREFERRED EMBODIMENT

According to a first embodiment of the present
15 invention, the electrical isolator has a housing 5 with both electromagnetic shielding and electrical conductivity properties. Aluminium housings are well suited for this purpose. An electronic device (not shown) to be protected is situated within the housing 5. As shown in Fig. 1, the
20 housing 5 has an aperture through which a connector 1 extends. The aperture is a circular hole. The connector 1 is a F-type connector having a circular cross section, and consists of an inner conductor 12 and an outer conductor 3 separated by insulating material 2,11. A high voltage
25 annular plastic ring 4 surrounds the outer conductor 3 and is countersunk into the outer surface of the housing 5. The inner surface of the plastic ring 4 abuts the outer conductor 3 thereby positioning connector 1 centrally in the aperture.

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The outer conductor 3 and inner conductor 12 of the connector 1 are both electrically connected to the electronic device within the housing 5. These connections can be either direct or via coupling components such as
35 capacitors or inductors.

A first annular ferrite spacer 16 surrounds the

outer conductor 3 thereby effectively plugging the gap between the outer conductor 3 and the housing created by the aperture. The inner surface of the first ferrite spacer 16 abuts the outer conductor 3. A first portion of the outer surface of the first ferrite spacer 16 abuts the housing 5. Ferrite material has very good electromagnetic shielding properties. External EMI is therefore impeded from entering the housing 5 through the aperture which is plugged with the first ferrite spacer 16. The first ferrite spacer 16 additionally assists with positioning connector 1 centrally in the aperture.

A second annular ferrite spacer 10 surrounds the outer conductor 3 within the housing 5 with an inner surface abutting the outer conductor 3.

A first capacitor 8 has a first electrode electrically connected to the housing 5 and a second electrode electrically connected to the outer conductor 3 at a point between the first ferrite spacer 16 and second ferrite spacer 10. The first capacitor 8 is a high voltage ring ceramic capacitor and surrounds a second portion of the outer curved surface of the first ferrite spacer 16 which extends inside the housing 5. There is an outer conductive shell 6 separated from the first capacitor 8 by insulation material 7. The second portion of the outer curved surface of the first ferrite spacer 16 abuts the inner curved surface of the first capacitor 8.

A screw 14 applies pressure to the first capacitor 8 such that: the outer conductive shell 6 maintains contact with the housing 5 thereby establishing a first electrical connection; the first electrode of the first capacitor 8 maintains contact with the housing 5 thereby establishing a second electrical connection; and the second electrode of the first capacitor 8 maintains contact with the outer conductor 3 thereby establishing a

third electrical connection.

A second capacitor 13 has a first electrode electrically connected to the housing 5, and a second
5 electrode electrically connected to the outer conductor 3 at a point on the side of the second ferrite spacer 10 which is distal from the first ferrite spacer 16. In Fig. 1, the first electrode of the second capacitor 13 is connected to the outer conductive shell 6 of the first
10 capacitor 8 which, in turn, is electrically connected to the housing 5.

The equivalent electrical network of the first embodiment is shown in Fig. 2. Point A corresponds to a
15 point on the outer conductor 3 on the side of the second ferrite spacer 10 which is distal from the first ferrite spacer 16. Point B corresponds to a point on the outer conductor 3 outside the housing 5. Point G corresponds to a point on the housing 5. Capacitor C_8 corresponds to the
20 first capacitor 8 and capacitor C_{13} corresponds to the second capacitor 13. Capacitors have a lower impedance at higher frequencies and therefore more readily couple noise into the housing 5.

25 Ferrite rings surrounding a wire carrying a signal, introduce an impedance to that wire which varies according to the frequency of the signal. The effective impedance introduced by a ferrite increases with increasing frequency of the signal and therefore higher
30 frequencies are attenuated by a greater degree. Therefore high frequency noise is attenuated to a greater extent than desired signals of lower frequencies. Impedance Z_{16} corresponds to the impedance introduced by the first ferrite 16 and impedance Z_{10} corresponds to the impedance
35 introduced by the second ferrite spacer 10.

Electrical signals are attenuated by the

electrical network of Fig. 2 as they pass from point B to point A in the outer conductor 3. The higher the signal frequency, the greater the signal attenuation. The network of Fig. 2 is therefore effectively a low pass filter.

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According to a second embodiment of the present invention, the electrical isolator has a plurality of ferrite spacers and capacitors thereby forming the electrical ladder network shown in Fig. 3. A n th order ladder network can be formed from n capacitors and n ferrite spacers, where n is an integer.

According to a third embodiment of the present invention, the electrical network is formed by a first ferrite spacer 16 and a first capacitor 8 only, as shown in Fig. 4. That is, the second ferrite spacer 10 and the second capacitor 13 of the first preferred embodiment is not included in the electrical isolator. Alternatively, the electronic device to be protected can be electrically connected to the outer conductor 3 at a point between the first ferrite spacer 16 and second ferrite spacer 10 thereby yielding the effective electrical circuit of Fig. 4.

The present invention is well suited for isolator terminals in CATV systems and broadband communication systems, and can provide up to 10dB reduced EMI over the prior art at frequencies greater than 100MHz. TV/FM splitters utilise such isolators operating between 5-1000MHz and have a single isolated input connector, and two separate output connectors for TV and FM signals respectively.

Various modifications will be apparent to persons skilled in the art, for example, the plastic ring may extend further into the aperture, or the housing may be formed from other suitable materials.

Such modifications should be considered as falling within the scope of the invention.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. An electrical isolator for protecting at least one
5 electronic device, said isolator having:
 - a housing which functions as an electromagnetic shield;
 - a connector extending through an aperture in said housing, said connector having an inner conductor and an
10 outer conductor separated by electrical insulator material, said inner conductor and said outer conductor being electrically connected to said at least one electronic device in use; and
 - a first ferrite spacer which surrounds said connector
15 and plugs a gap between said connector and said housing, whereby said first ferrite spacer impedes electromagnetic interference (EMI) from entering said housing through said gap.
- 20 2. An electrical isolator as claimed in claim 1, wherein said housing is an electrical conductor and said electrical isolator further comprises a first capacitor which electrically couples said housing to said outer conductor, said first ferrite spacer introducing a first
25 impedance in said outer conductor, and said first capacitor combines with said first impedance and said housing to form an electrical network for attenuating electrical noise entering said housing in said outer conductor.
- 30 3. The electrical isolator as claimed in claim 2 having a second ferrite spacer, said second ferrite spacer surrounding said outer conductor within said housing, wherein:
35 said second ferrite spacer introduces a second impedance in said outer conductor thereby increasing the effective impedance of said outer conductor.

4. The electrical isolator as claimed in claim 2 wherein:

5 said first capacitor is electrically connected to said housing by a first electrode, and has a second electrode electrically connected to said outer conductor at a point between said first ferrite and said second ferrite; and

10 said electrical isolator further comprises a second capacitor with a first electrode electrically connected to said housing, and a second electrode electrically connected to said outer conductor at a point on a side of said second ferrite spacer which is distal from said first ferrite spacer.

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5. The electrical isolator device as claimed in claim 4, having at least one additional capacitor and at least one additional ferrite to thereby form a ladder network of ferrite impedances and capacitors.

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6. The electrical isolator device as claimed in claim 2 wherein said network is a low pass filter.

25 7. The electrical isolator device as claimed in claim 1 having at least one additional connector.

8. A device comprising:

electrical isolator as claimed in any one of claims 1 to 7; and

30 an electronic circuit.

9. A device as claimed in claim 8 when appended to claim 7, wherein the electronic circuit is a TV signal splitting circuit.

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