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(71) Applicant: **Connaught Electronics Ltd.**
Tuam, County Galway (IE)

(72) Inventor: **MCDONAGH, Mark**
Tuam, County Galway, - (IE)

(74) Representative: **Jauregui Urbahn, Kristian**
Valeo Schalter und Sensoren GmbH
CDA-IP
Laiernstraße 12
74321 Bietigheim-Bissingen (DE)

(54) **ELECTRONIC CONTROL UNIT**

(57) An electronic control unit, ECU, comprises a body portion comprising a shell at least a portion of which is conductive. A printed circuit board, PCB, is positioned within the body portion. At least one electrical connector is connected to the PCB and extends from the PCB through a respective aperture in the shell. The electrical connector comprises a signal conductor surrounded by a co-axial ground shield, the co-axial ground shield being electrically coupled to a ground plane of the PCB. An electrically conductive foam collar is located around a co-axial ground shield of a respective electrical connector. The electrically conductive foam collar is resiliently deformable so as to be clamped between the conductive portion of the shell and the co-axial ground shield of the respective electrical connector to provide an electrical sealing of the shell.

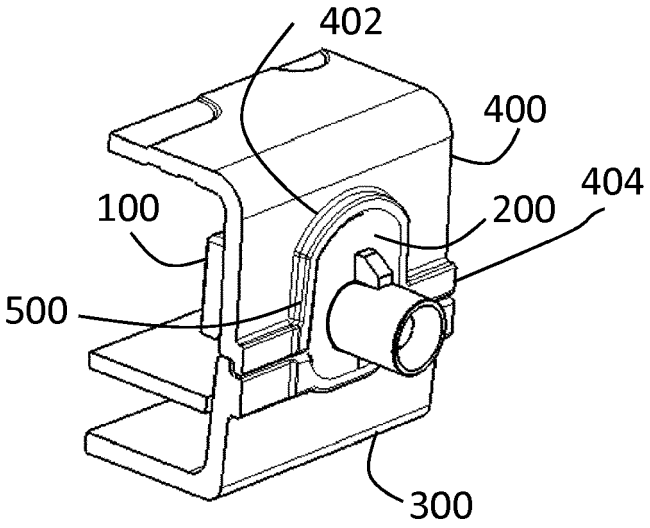

Figure 5

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Description

Field

[0001] The present application relates to an electronic control unit (ECU).

Background of The Invention

[0002] Electronic control units (ECUs) for vehicle engines typically comprise a microprocessor, possibly along with other co-processors, and other electrical and electronic components mounted on a printed circuit board (PCB) with one or more signal conductors extending from the PCB in order to connect the microprocessor to a vehicle control network, for example, a Controller Area Network (CAN) Bus, external sensors or telemetry equipment or a vehicle antenna in order to control the vehicle.

[0003] As is well appreciated, vehicle engine compartments in particular can be difficult operating environments and in order to shield the ECU, it is typical for an ECU to be enclosed in a protective housing or shell.

[0004] Such housings can provide robust environmental protection, although any points from which signal conductors pass through the housing can represent a point of failure, making the PCB especially prone to electromagnetic noise or interference (EMI) or effect the electromagnetic compatibility (EMC) of the ECU.

[0005] In the case of electrically conductive housings, metal spring connectors can be employed to bridge between signal conductors and the housing to shield against EMI and maintain EMC, however, such connections may not be sufficiently reliable or robust and can be prone to failure.

[0006] Other solutions involve electrically conductive paste or tape but these can be labour intensive to apply and can also suffer from reliability problems.

[0007] It is an object of the present invention to provide an improved electronic control unit.

Summary

[0008] According to the present invention, there is provided an electronic control unit (ECU) according to claim 1. Advantageous embodiments are provided in the dependent claims.

[0009] Embodiments include a foam collar for each connector extending from an ECU PCB and which in use provides contact between the electrical connector and the housing of the ECU, thereby reducing EMC/EMI, issues.

[0010] Foam collars employed in embodiments of the present invention can be readily sized and shaped to fit or be retro-fitted to any connector to seal any aperture of an ECU housing.

[0011] Such collars can be compressed in a number of directions and so provide a high degree of tolerance in fitting. Thus, use of such foam collars allows for a 360° contact on cylindrical and non-cylindrical openings.

Brief Description of The Drawings

[0012] An embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a perspective view of a co-axial electrical connector connected to a PCB for an ECU according to an embodiment of the present invention;

Figure 2 is a perspective view of an electrically conductive foam collar for an ECU according to an embodiment of the present invention;

Figure 3 is a perspective view of the electrical connector of Figure 1 with the electrically conductive foam collar of Figure 2 located around a ground shield of the electrical connector;

Figure 4 is a perspective view of the electrical connector and the electrically conductive foam collar of Figure 3 with the electrically conductive foam collar clamped between a shell portion of a housing and the ground shield of the electrical connector; and

Figure 5 is a perspective view of the electrical connector and the electrically conductive foam collar of Figure 3 within a two-part shell, each part being fixed together to clamp the electrically conductive foam collar against the ground shield of the electrical connector.

Detailed Description of The Embodiment

[0013] Referring now to Figure 1, there is shown a portion of a printed circuit board (PCB) 106 for an electronic control unit (ECU) according to an embodiment of the present invention. An electrical connector 100 is mounted on the PCB 106. The electrical connector 100 may be one of a plurality of electrical connectors extending from the PCB 106, however, only one is shown, but it will be appreciated that the principals described for the connector of Figure 1 are equally applicable to other connectors extending from the PCB.

[0014] In the illustrated example, the electrical connector 100 comprises a conventional type radio frequency (RF) right-angled jack comprising a mount 101 including a plurality of connections through to the PCB (only some of the ground plane connections 103 are shown), with the signal conductor extending from a signal trace on the PCB, within the mount and bending through 90 degrees within the mount to extend in a plane parallel to the PCB and away from the edge of the PCB. The signal conductor 102 is surrounded by a co-axial ground shield 104, with the co-axial ground shield 104 being electrically coupled to the ground plane (not shown) of the PCB 106 through the mount 101.

[0015] In the illustrated example, a lug 108 is formed on an external surface of the ground shield 104. The lug

108 can be of a type to facilitate a Bayonet Neill-Concelman (BNC) or similar connection with a signal lead (not shown) extending from the ECU, but it can also be provided specifically to facilitate the present invention.

[0016] It will nonetheless be appreciated that the present invention is applicable to many different forms of both RF connector and non-RF connectors including screw type Sub-Miniature version A (SMA) connectors or push-on connectors.

[0017] It will also be seen that while in the illustrated example, the jack 100 is right-angled, in variations of the example, the jack could extend vertically from the PCB 106.

[0018] Referring now to Figure 2, there is shown an electrically conductive foam collar 200 for the connector 100 of Figure 1. The electrically conductive foam collar 200 has a generally toroidal shape having an inner aperture 202 and an outer periphery 204. (It will be appreciated that the outer periphery as in this case need not be strictly circular, but its shape will be defined by the aperture it is to be located in as will be explained below.) In the illustrated embodiment the foam collar 200 has a slit 206 running from the inner aperture 202 to the outer periphery 204. The electrically conductive foam collar 200 may be for example, formed of PORON® Condux Plus™ by Rogers corporation. PORON® Condux Plus™ provides extremely low electrical resistance of less than 1.29032×10^{-6} Ohm/m^2 (0.002 Ohm/in^2) and so acts as an excellent conductor.

[0019] Referring now to Figure 3, the electrically conductive foam collar 200 can be fitted around the co-axial ground shield 104 of a respective electrical connector 100. As will be seen, the collar 200 can be located between the mount 101 and the lug 108 to maintain the position and orientation of the collar on the shield 104 prior to further assembly. The collar 200 can be pushed over the end of the connector into the required location or especially because of the presence of the slit 206, it can be pushed onto the connector 100 from the side.

[0020] Referring now to Figure 4, the ECU in accordance with the preferred embodiment of the present invention comprises a two-part shell. Typically, the PCB 100 is first located in one portion 300 of the shell with any connectors such as the connector 100 extending past the wall of the shell. In the illustrated example, an edge 304 of the shell comprises a recess 302 providing a gap between the shield 104 and the wall of the shell portion 300 which is filled by the foam collar 200.

[0021] Referring now to Figure 5, once the PCB has been located in the first portion 300 of the shell, a second portion 400 of the shell can be fitted to the first portion 300. The second portion comprises an edge 404 and when the shell portions 300, 400 are brought into contact, they mate along the edges 304, 404. In the illustrated example, the edge 404 of the second portion of the shell also comprises a recess 402 which lies in register with the recess 302 to form an aperture 500 through which the electrical connector 100 passes and which is sealed by the foam collar 200.

[0022] As will be seen, the electrically conductive foam collar 200 is located and placed between the connector 100 and the recesses 302, 402 of the shell so that, if the collar is fitted to the connector during assembly of the ECU and before the connector 100 is located in the housing, when the housing is clamped over it, it will be in register with the edge recesses 302, 402 thereby providing an electrical sealing of the shell 300, 400.

[0023] The fitting together of the mating edges 304, 404 of each shell 300, 400 of the two-part shell clamps the electrically conductive foam collar 200 against the co-axial ground shield 104 of the electrical connector 100. The shell portions 300, 400 can be clamped together using, for example, screw type fittings or snap fit type fittings (not shown). The shell portions 300, 400 are at least partially conductive and, in some cases, comprise a metal casing.

[0024] The electrically conductive foam collar 200 is resiliently deformable so that when clamped between the conductive portions of the shell 300, 400 and the co-axial ground shield 104 of the respective electrical connector 100, the collar acts as an electrically conductive gasket to close gaps between the ECU shell 300, 400, PCB 106 and electrical connector 100 to provide an electrical sealing of the shell 300, 400. As will be appreciated, this helps to reduce EMC/EMI, issues.

[0025] It will be appreciated, with the slit 206 provided, that in some cases the electrically conductive foam collar 200 can be retrofitted to the ECU by pushing it into the aperture 500, thereby enabling the electrically conductive foam collar 200 to be fitted to the ECU after the PCB 106 has been positioned within the shell. In particular, the slit 206 in the electrically conductive foam collar 200 allows for its introduction to the assembly of the ECU at any or multiple points in the production process.

[0026] The electrically conductive foam can be cut to size from sheets, allowing for uniform contact between the connector 100 and the shell 300, 400 of the ECU.

[0027] In other embodiments not illustrated, the electrically conductive foam collar can be clamped between the connector mount 101 and the inside surface of a wall conductive portion of the shell rather than between two edges of the shell. Again, the electrically conductive foam collar would be compressed between the inside wall of the conductive portion of the shell and the connector mount 101 to provide an electrical sealing of the shell.

Claims

1. An electronic control unit, ECU, comprising:

a body portion comprising a shell (300, 400) at least a portion of which is conductive;
a printed circuit board, PCB (106) positioned within the body portion;
at least one electrical connector connected to

the PCB and extending from the PCB through a respective aperture (500) in said shell, wherein the at least one electrical connector comprises a signal conductor (102) surrounded by a co-axial ground shield (104), the co-axial ground shield being electrically coupled to a ground plane of the PCB; and

at least one electrically conductive foam collar (200), the or each collar located around a co-axial ground shield of a respective electrical connector;

wherein the or each electrically conductive foam collar is resiliently deformable so as to be clamped between the conductive portion of the shell and the co-axial ground shield of the respective electrical connector to provide an electrical sealing of the shell.

2. The electronic control unit of claim 1 wherein the or each electrically conductive foam collar comprise a generally toroidal shape having an inner aperture (202) and an outer periphery (204), the or each electrically conductive foam collar having a slit (206) running from said inner aperture to said outer periphery enabling the or each electrically conductive foam collar to be fitted to said ECU after said PCB has been positioned within said body portion.

3. The electronic control unit of claim 1, wherein the shell is a two-part shell (300,400), each part being fixed together to clamp the or each electrically conductive foam collar against the respective co-axial ground shield of the respective electrical connector.

4. The electronic control unit of claim 3, wherein each part of said shell is fixed together along mating edges (302,402), a mating edge of at least one part being recessed (304, 404) to define the or each aperture through which the or each electrical connector passes.

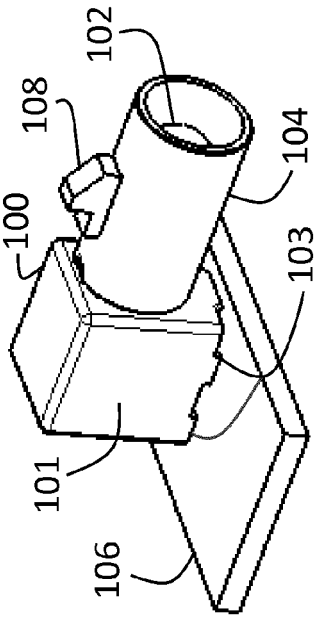

Figure 1

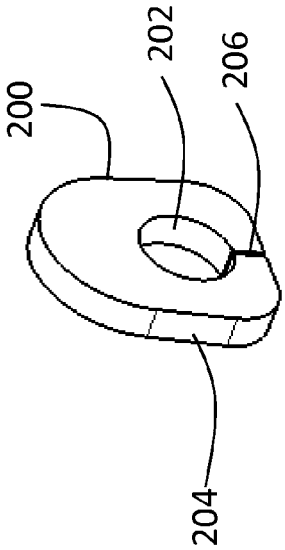

Figure 2

Figure 3

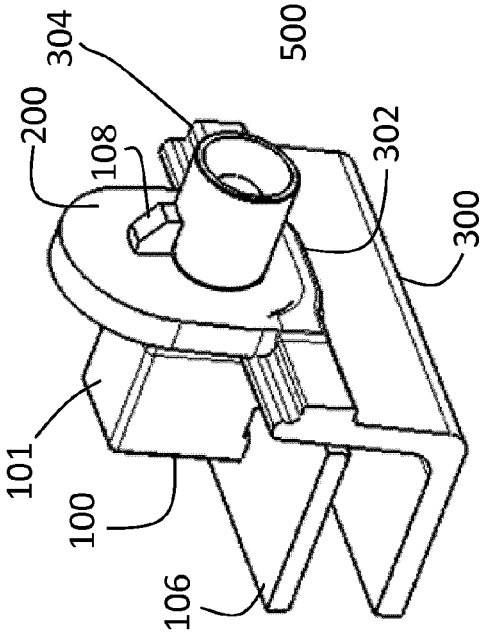

Figure 4

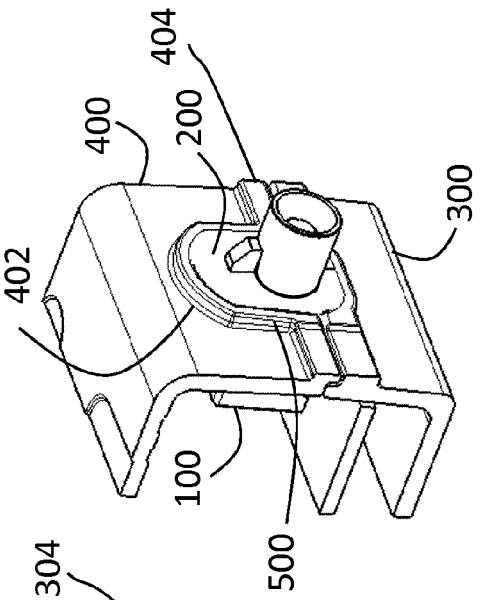

Figure 5

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EUROPEAN SEARCH REPORT

Application Number
EP 18 21 2526

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 9 787 032 B1 (TALALAYEV ANTON [US] ET AL) 10 October 2017 (2017-10-10) * column 12, line 6 - line 63 * * column 14, line 25 - line 31 * * figures 16-18, 24 *	1-4	INV. H01R13/6584 H01R24/50
A	US 2012/058651 A1 (WANG CHIEN-CHIUNG [TW] ET AL) 8 March 2012 (2012-03-08) * paragraph [0017] - paragraph [0023] * * figures 2-5 *	2,4	

TECHNICAL FIELDS SEARCHED (IPC)

H01R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	14 May 2019	Henrich, Jean-Pascal

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 18 21 2526

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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14-05-2019

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 9787032 B1	10-10-2017	NONE	
US 2012058651 A1	08-03-2012	CN 201829687 U	11-05-2011
		US 2012058651 A1	08-03-2012

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82