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Description

This invention relates generally to electrical feedthroughs and, more particularly to an hermetically sealed coaxial cable feedthrough.

Hermetically sealed casings are used extensively to package a variety of hybrid microcircuits. Typically, glass-to-metal seals are employed to hermetically seal and electrically isolate one or more lead wires from a package body. Generally, the hermetic seal is produced by fusing glass between the lead wire and the package body. Such hybrid packages provide, for microelectronic circuits, enclosures that are electrically accessible but completely isolated from external hostile environments.

Significant problems encountered during the creation of hermetically sealed packages stem from requirements for internal circuitry routing. The use of either elongated pin feedthroughs or gold ribbons to reach internal circuitry often results in impedance mismatches. Conversely, the interconnection of internal circuitry and feedthrough pins with coaxial cable assemblies entails sensitive soldering procedures that can damage individual components, particularly the fragile inner conductors of the cable assemblies.

European Patent Application EP-A-0 229 549 discloses a feedthrough assembly having an inner conductor hermetically sealed to a flange adapter by a glass bead. The adapter is adapted for connection to an outer conductor electrically isolated from the inner conductor by insulation and for mounting in a wall panel of an enclosure. However, in order to facilitate hermetic sealing to the glass bead and the wall panel, the adapter is made of a magnetic material such as ferro-nickel. Such materials provide the assembly with undesirable magnetic properties.

The object of this invention, therefore, is to provide an improved feedthrough for hermetically sealed packages.

According to the present invention an hermetically sealed electrical feedthrough assembly comprises an elongated inner electrical conductor having first and second ends, a glass body hermetically sealed around one length portion of the inner conductor adjacent to the first end thereof, a metal adapter with a solderable material hermetically sealed around the glass body and adapted for mounting in a wall of a housing, a tubular outer electrical conductor enclosing and coaxial with another length portion of the inner electrical conductor, the outer electrical conductor being separated from the inner electrical conductor by an annular volume and having one end portion electrically connected to the metal adapter and an opposite end portion disposed adjacent to the second end of

the inner electrical conductor and electrical insulation filling the annular volume and electrically isolating the outer electrical conductor from the length portion of the inner electrical conductor, characterized in that the inner electrical conductor and the metal adapter are made of a substantially non-magnetic material plated with a solderable material. High performance interconnections with microcircuitry in an hermetically sealed housing is facilitated by the disclosed assembly.

According to specific features of the invention, the adapter defines an outer cylindrical cavity extending inwardly from an outer end thereof and an inner cylindrical cavity extending inwardly from an inner end thereof and coaxially aligned with the outer cylindrical cavity, the outer cylindrical cavity retaining the glass body, and the inner cylindrical cavity retaining an end section of the outer electrical conductor. These features provide the desired assembly in a structurally efficient arrangement.

According to another feature of the invention, the adaptor defines a circumferential flange with an annular surface for engaging the wall of the housing, the annular surface facing toward the inner end. The circumferential flange accommodates mounting of the assembly in the hermetically sealed housing.

According to still other features of the invention, the inner and outer cylindrical cavities are separated by a central cavity defined by an annular rib having an inner surface facing the inner cylindrical cavity and an outer surface facing the outer cylindrical cavity, the inner surface engages said glass body, the diameter of the inner cylindrical cavity is less than the diameter of the outer cylindrical cavity and another length portion of the inner electrical conductor extends between the second end thereof and the central cavity.

According to yet other features of the invention, the inner electrical conductor and the adapter are made of stainless steel and plated with an alloy comprising nickel and gold and the outer electrical conductor is made of a ductile, electrically conductive material. The disclosed conductor and adapter materials facilitates both hermetic sealing and soldering operations while the ductile outer conductor is easily manipulated during interconnection procedures.

The invention further includes a method for producing an hermetically sealed electrical feedthrough assembly and constituted by the steps of providing a cylindrical glass body with an axial passage, providing a substantially non-magnetic metal adapter with an outer cylindrical cavity extending inwardly from an outer end thereof and conforming to the glass body, providing an elongated substantially non-magnetic inner electrical conductor, providing an elongated, tubular outer

electrical conductor having an inner surface engaged by an elongated cylindrical insulator defining a central passage coaxially aligned with the outer electrical conductor and conforming in shape to the inner electrical conductor, inserting one length portion of the inner electrical conductor into the axial passage, inserting the glass body into the outer cylindrical cavity, applying heat so as to produce a hermetic seal between the glass body and both the adapter and the length portion of the inner electrical conductor, plating exposed portions of the adapter and inner electrical conductor with solderable material subsequently pressing another length portion of the inner electrical conductor into the central passage and electrically connecting the outer electrical conductor to the adapter. This method provides the desired assembly in a simple, efficient manner.

According to the other method features of the invention, the adapter defines an inner cylindrical cavity axially aligned with the outer cylindrical cavity and a central cavity separating the inner and outer cylindrical cavities and defined by a ridge having an inner annular surface facing the inner cylindrical cavity, and the pressing step comprises moving an end of the outer electrical conductor into the inner cavity and into engagement with the inner annular surface. These steps simplify production of the assembly.

According to still other method features, the inner electrical conductor and the adapter are made of stainless steel and are plated before the pressing step. The use of plated stainless steel facilitates both hermetic sealing and soldering of the inner conductor and adapter while performing the plating step before insertion of the outer conductor reduces plating costs and minimizes the addition of undesirable magnetic properties to the assembly.

These and other objects and features of the invention will become more apparent upon a perusal of the following description taken in conjunction with the accompanying drawings wherein:

Fig. 1 is a right perspective view of an hermetically sealed electrical feedthrough assembly according to the invention;

Fig. 2 is a left perspective view of the assembly shown in Fig. 1;

Fig. 3 is a sectional view taken along the lines 3-3 of Fig. 1;

Fig. 4 is a right end view of the assembly shown in Fig. 1; and

Fig. 5 is a left end view of the assembly shown in Fig. 1.

A preferred embodiment of an electrical feedthrough assembly 11 is illustrated in Figs. 1-5. Included in the assembly 11 are a metal adapter 12 and a cylindrical glass body 13 and a coaxial cable

14 both retained thereby. The adapter 12 has an outer cylindrical portion 15 joined to an inner cylindrical portion 16 of reduced diameter and both axially aligned with the coaxial cable 14. Projecting outwardly from the outer cylindrical portion 15 is a circumferential flange 17 that defines an annular surface 18 facing toward the coaxial cable 14. Further defined by the outer cylindrical portion 15 is an outer cylindrical cavity 19 that retains and conforms in shape to the glass body 13, which also is axially aligned with the cable 14. The glass body 13 is hermetically sealed within the outer cylindrical cavity 19 of the adapter 12 and defines an axial passage 21.

Forming the coaxial cable 14 is an elongated inner electrical conductor 22 and an elongated and coaxial, tubular outer electrical conductor 23 separated therefrom by an annular space filled with an electrical insulation material 24. One length portion 25 of the inner conductor 22 adjacent to a first end 26 thereof is received by and hermetically sealed in the axial passage 21 of the glass body 13. Another length portion 28 of the inner conductor 22 between a second end 29 thereof and the one length portion 25 is received by a central passage 31 in the electrical insulation 24. Electrically connected to the adapter 12 by solder 32 is one end portion 33 of the outer conductor 23 while an opposite end portion 34 terminates adjacent to the second end 29 of the inner conductor 22.

An inner cylindrical cavity 35 is formed in the reduced diameter inner portion 16 of the adapter 12. The inner cavity 35 is axially aligned with the outer cavity 19 and is separated therefrom by a central cavity 36 defined by an inwardly directed annular rib 37 projecting inwardly from the outer portion 15 of the adapter 12. Defined by the annular rib 37 is an outer shoulder surface 38 engaged by the glass body 13 and an inner shoulder surface 39. An end section 41 of the one end portion 33 of the outer conductor 23 conforms in shape to and is received by the inner cylindrical cavity 35. Engaging the inner shoulder surface 39 of the annular rib 37 is an end 42 of the end section 41.

According to a preferred embodiment of the assembly 11, the adapter 12 and the inner conductor 22 are made of stainless steel plated with a nickel, gold alloy; the outer conductor 23 is made of ductile, electrically conductive material such as copper; and the electrical insulation 24 is a suitable dielectric. In typical use, the outer portion 15 of the adapter 12 is inserted through an opening 44 in a housing 45 to produce engagement thereof with the annular surface 18 on the circumferential flange 17. A hermetic seal then is established between the housing 45 and the adapter 12 by solder 46 applied between the housing 45 and the circum-

ferential flange 17. The second end 29 of the inner conductor 22 and the opposite end portion 34 of the outer conductor 23 then are electrically connected to circuitry (not shown) to be hermetically sealed within the housing 45. A conventional female socket connector then can be coupled to the first end 26 of the inner conductor 22 so as to provide for the transmission of electrical signals through the walls of the housing 45.

In accordance with a preferred method of construction for the assembly 11, the length portion 25 of the inner conductor 22 is inserted into the axial passage 21 of the glass body 13 which then is inserted into the outer cylindrical cavity 19 of the adapter 12. Sequential heating and cooling produces non-uniform expansion of the glass body 13 relative to the stainless steel inner conductor 22 and adapter 12 and resultant compression therebetween that creates an hermetic seal. After the sealing step, the exposed surfaces of the inner conductor 22 and the adapter 12 are plated with a nickel, gold alloy. The gold in the plating finish enhances the electrical conductivity of the inner conductor 22 and the adapter 12 so as to reduce the RF insertion losses of the completed cable assembly 11, while the nickel content both facilitates subsequent soldering operations on the adapter 12 and functions as a barrier to prevent the migration of contaminants through the gold and nickel layer. Next, the previously combined outer conductor 23 and insulation 24 are assembled as a composite body by pressing the length portion 28 of the inner conductor 22 into the central passage 31. During this assembly step, the end section 41 of the outer conductor 23 is inserted into the inner cylindrical cavity 35 of the adapter 12 until the end 42 of the outer conductor 23 engages the inner surface 39 of the rib 37. Finally, the outer conductor 23 is secured to the adapter 12 by the application of solder 32 therebetween.

Claims

1. An hermetically sealed electrical feedthrough assembly comprising an elongated inner electrical conductor (22) and having first (26) and second ends (29), a glass body (13) hermetically sealed around one length portion (25) of the inner conductor adjacent to the first end thereof, a metal adapter (12) hermetically sealed around the glass body and adapted for mounting in a wall of a housing, a tubular outer electrical conductor (23) enclosing and coaxial with another length portion (28) of the inner electrical conductor (22), the outer electrical conductor (23) being separated from the inner electrical conductor (22) by an annular volume and having one end portion (33) electrically connected to the metal adapter (12) and an opposite end portion (34) disposed adjacent to the second end (29) of the inner electrical conductor (27) and electrical insulation (24) filling the annular volume and electrically isolating the outer electrical conductor (23) from the length portion (28) of the inner electrical conductor, characterized in that the inner electrical conductor (22) and the adapter (12) are made of a substantially non-magnetic material plated with a solderable material.
2. An assembly according to claim 1, characterized in that the adapter defines an outer cylindrical cavity (19) extending inwardly from an outer end thereof and an inner cylindrical cavity (35) extending inwardly from an inner end thereof and coaxially aligned with the outer cylindrical cavity, the outer cylindrical cavity (19) retaining the glass body (13) and the inner cylindrical cavity (35) retaining an end section (41) of the outer electrical conductor (23).
3. An assembly according to claim 2, characterized in that the inner and outer cylindrical cavities (19, 35) are separated by a central cavity (36) defined by a projection (37) having an inner surface (39) facing the inner cylindrical cavity (35) and an outer surface (38) facing the outer cylindrical cavity (19) and wherein the inner surface (39) engages the outer electrical conductor (23) and the outer surface (38) engages the glass body (13).
4. An assembly according to claim 3, characterized in that the projection (37) comprises an annular rib (37).
5. An assembly according to claim 4, characterized in that the diameter of the inner cylindrical cavity (35) is less than the diameter of the outer cylindrical cavity (19).
6. An assembly according to claim 5, characterized in that the length portion (28) of the inner electrical conductor (22) extends between the second end (29) thereof and the central cavity (36).
7. An assembly according to claim 6, characterized in that the inner electrical conductor (22) and the adapter (12) are made of stainless steel and plated with an alloy comprising nickel and gold.
8. An assembly according to claim 7, characterized in that the outer electrical conductor (23) is made of a ductile, electrically conductive

material.

9. An assembly according to claim 1, characterized in that the adapter (12) is one-piece and defines a circumferential flange (17) with an annular surface (18) for engaging the wall of the housing, the annular surface facing toward the second end (29). 5
10. A method for producing an hermetically sealed electrical feedthrough assembly and comprising the steps of providing a cylindrical glass body (13) with an axial passage (21), providing a substantially non-magnetic metal adapter (12) with an outer cylindrical cavity (19) extending inwardly from an outer end thereof and conforming to the glass body, providing an elongated substantially non-magnetic inner electrical conductor (22), providing an elongated, tubular outer electrical conductor (23) having an inner surface engaged by an elongated cylindrical insulator (24) defining a central passage (31) coaxially aligned with the outer electrical conductor and conforming in shape to the inner electrical conductor, inserting one length portion (25) of the inner electrical conductor (22) into the axial passage (21), inserting the glass body (13) into the outer cylindrical cavity (19), applying heat so as to produce a hermetic seal between the glass body (13) and both the adapter (12) and the length portion (25) of the inner electrical conductor (22), plating exposed portions of the adapter (12) and inner electrical conductor (22) with a solderable material, subsequently pressing another length portion (28) of the inner electrical conductor (22) into the central passage (31) and electrically connecting the outer electrical conductor (23) to the adapter (12). 10 15 20 25 30 35 40

Revendications

1. Un ensemble de traversée électrique hermétiquement étanche comprenant un conducteur électrique intérieur allongé (22) et présentant une première (26) et une seconde extrémité (29), un corps en verre (13) hermétiquement étanche autour d'une partie de la longueur (25) du conducteur intérieur adjacente à la première extrémité de celui-ci, un adaptateur métallique (12) hermétiquement étanche autour du corps en verre et adapté pour être monté dans une paroi d'un boîtier, un conducteur électrique extérieur tubulaire (23) renfermant une autre partie (28) de la longueur du conducteur électrique intérieur (22) et coaxial à celle-ci, le conducteur électrique extérieur (23) étant séparé du conducteur électrique intérieur (22) par 45 50 55

un volume annulaire et présentant un partie d'extrémité (33) électriquement reliée à l'adaptateur métallique (12) et une partie d'extrémité (34) opposée disposée adjacente à la seconde extrémité (26) du conducteur électrique intérieur (22) et une isolation électrique (24) remplissant le volume annulaire et isolant électriquement le conducteur électrique extérieur (23) de la partie (28) de la longueur du conducteur électrique intérieur, caractérisé en ce que le conducteur électrique intérieur (22) et l'adaptateur métallique (12) sont réalisés en un matériau sensiblement non-conducteur plaqué d'un matériau pouvant être soudé.

2. Un ensemble suivant la revendication 1, caractérisé en ce que l'adaptateur définit une cavité cylindrique extérieure (19) s'étendant vers l'intérieur à partir d'une extrémité extérieure de celui-ci et une cavité cylindrique intérieure (35) s'étendant vers l'intérieur à partir d'une extrémité intérieure de celui-ci et en alignement coaxial avec la cavité cylindrique extérieure, la cavité cylindrique extérieure (19) retenant le corps en verre (13) et la cavité cylindrique intérieure (35) retenant un segment d'extrémité (41) du conducteur électrique extérieur (23).
3. Un ensemble suivant la revendication 2, caractérisé en ce que les cavités cylindriques intérieure et extérieure (19, 35) sont séparées par une cavité centrale (36) définie par une saillie (37) présentant une surface intérieure (39) orientée vers la cavité cylindrique intérieure (35) et une surface extérieure (38) orientée vers la cavité cylindrique extérieure (19) et dans laquelle la surface intérieure (39) vient en prise avec le conducteur électrique extérieur (23) et la surface extérieure (38) vient en prise avec le corps en verre (13).
4. Un ensemble suivant la revendication 3, caractérisé en ce que la saillie (37) comprend une nervure annulaire (37).
5. Un ensemble suivant la revendication 4, caractérisé en ce que le diamètre de la cavité cylindrique intérieure (35) est inférieur au diamètre de la cavité cylindrique extérieure (19).
6. Un ensemble suivant la revendication 5, caractérisé en ce que la partie (28) de la longueur du conducteur électrique intérieur (22) s'étend entre la seconde extrémité (29) de celui-ci et la cavité centrale (36).
7. Un ensemble suivant la revendication 6, caractérisé en ce que le conducteur électrique inté-

rieur (22) et l'adaptateur (12) sont réalisés en acier inoxydable et plaqués d'un alliage comprenant du nickel et de l'or.

8. Un ensemble suivant la revendication 7, caractérisé en ce que le conducteur électrique extérieur (23) est réalisé en un matériau malléable électriquement conducteur. 5
9. Un ensemble suivant la revendication 1, caractérisé en ce que l'adaptateur (12) est en une seule pièce et définit une bride circonférentielle (17) avec une surface annulaire (18) pour venir en prise avec la paroi du boîtier, la surface annulaire étant orientée vers la seconde extrémité (29). 10 15
10. Une méthode pour la production d'un ensemble de traversée électrique hermétiquement étanche et comprenant les étapes consistant à 20
 - prévoir un corps en verre cylindrique (13) avec un passage axial (21), prévoir un adaptateur métallique (12) sensiblement non-magnétique avec une cavité cylindrique extérieure (19) s'étendant vers l'intérieur à partir d'une extrémité extérieure de celui-ci et se conformant au 25
 - corps en verre, prévoir un conducteur électrique intérieur allongé sensiblement non-magnétique (22), prévoir un conducteur électrique extérieur tubulaire allongé (23) présentant une surface intérieure avec laquelle vient en prise un isolateur cylindrique allongé (24) définissant un passage central (31) en alignement coaxial avec le conducteur électrique extérieur et se conformant, dans sa forme, au conducteur électrique intérieur, introduire une partie (25) de la longueur du conducteur électrique intérieur (22) dans le passage axial (21), introduire le corps en verre (33) dans la cavité cylindrique extérieure (19), appliquer de la chaleur, de manière à produire un joint hermétique entre le corps en verre (13) et tant l'adaptateur (12) que la partie (25) de la longueur du conducteur électrique intérieur (22), plaquer les parties exposées de l'adaptateur (12) et du conducteur électrique intérieur (22) d'un matériau pouvant être soudé, presser ensuite une autre partie (28) de la longueur du conducteur électrique intérieur (22) dans le passage central (31) et relier électriquement le conducteur électrique extérieur (23) à l'adaptateur (12). 30 35 40 45 50

Patentansprüche

1. Hermetisch abgedichtete elektrische Durchführung durch eine Gehäusewandung, bestehend aus einem Koaxialkabel (14), dessen äußerer rohrförmiger Leiter (23) den inneren gestreck-

ten Leiter (22) unter Belassung eines mit einer Füllung aus nichtleitendem Material (24) befüllten Zwischenraums umgibt, wobei der innere Leiter (22) an beiden Enden über den äußeren Leiter (23) vorspringt (25, 26 u. 29), einem einen Ends (25) den inneren Leiter (22) unter Belassung eines Überstandes (26) dichtend umgebenden Glaskörper (13) und einem den Glaskörper (13) dichtend umgebenden metallischen, in einen Durchgang (44) in der Gehäusewandung (43) einfügbaren Stopfen (12), mit dem das ihm zugekehrte Ende (33) des äußeren Leiters (23) des Koaxialkabels (14) elektrisch leitend verbunden ist (32), dadurch gekennzeichnet, daß der innere Leiter (22) des Koaxialkabels (14) und der Stopfen (12) aus unmagnetischem Material bestehen, das mit lötbarem Material plattiert ist.

2. Durchführung nach Anspruch 1, dadurch gekennzeichnet, daß der Stopfen (12) einen von der Außenseite ausgehenden hohlzylindrischen, sich in den Stopfen hinein erstreckenden Rücksprung (19) aufweist und einen von der Innenseite ausgehenden, sich in den Stopfen hinein erstreckenden, mit dem äußeren Rücksprung (19) fluchtenden, hohlzylindrischen Rücksprung (35), von denen der von der Außenseite ausgehende Rücksprung (19) den zylindrischen Glaskörper (13) aufnimmt und der von der Innenseite ausgehende Rücksprung (33) den Endbereich (41) des äußeren elektrischen Leiters (23).
3. Durchführung nach Anspruch 2, dadurch gekennzeichnet, daß die äußere und die innere Aufnahme (19, 35) im Stopfen (12) unter Belassung eines Durchganges (36) im Abstand voneinander unter Ausbildung einer Einschubbegrenzung (38) für den Glaskörper (13) sowie einer Einschubbegrenzung (39) für den äußeren Leiter (23) enden.
4. Durchführung nach Anspruch 3, dadurch gekennzeichnet, daß die Einschubbegrenzungen (38 und 39) durch einen Durchgang (36) kleineren Durchmessers als die Durchmesser sowohl der äußeren Aufnahme (19) als auch der inneren Aufnahme (35) des Stopfen (12) ausgebildet sind.
5. Durchführung nach Anspruch 4, dadurch gekennzeichnet, daß der Durchmesser der inneren Aufnahme (35) kleiner ist als der Durchmesser der äußeren Aufnahme (19).
6. Durchführung nach Anspruch 5, dadurch gekennzeichnet, daß der Grund (39) der Aufnah-

me (35) und das freie Ende (34) des äußeren Leiters (23) einen Bereich (28) des inneren Leiters (22) definieren.

7. Durchführung nach Anspruch 6, dadurch gekennzeichnet, daß der innere Leiter (22) und der Stopfen (12) aus rostfreiem Stahl bestehen und mit einer Nickel und Gold enthaltenden Legierung plattiert sind. 5
8. Durchführung nach Anspruch 7, dadurch gekennzeichnet, daß der äußere Leiter (23) aus elektrisch leitendem, verformbarem (duktilen) Material besteht. 10
9. Durchführung nach Anspruch 1, dadurch gekennzeichnet, daß der einstückig ausgebildete Stopfen (12) einen peripheren Flansch (17) mit einer inneren, gegen die Gehäusewandung (45) zur Anlage kommenden Ringschulter (18) aufweist. 15 20
10. Verfahren zur Herstellung einer hermetisch abgedichteten elektrischen Durchführung, dadurch gekennzeichnet, daß ein zylindrischer Glaskörper (13) mit einem zentralen Durchgang (21) vorgesehen wird, ein unmagnetischer metallischer Stopfen (12) mit einer äußeren, auf den Glasstopfen (13) ausgelegter Aufnahme, ein gestreckter innerer Leiter (22) und ein rohrförmiger äußerer Leiter (23) mit darin eingefügtem, sich gegen seine Innenwandung abstützendem zylindrischen Isolator (24) mit einem zentralen, der Form des inneren Leiters (22) angepaßten, sich coaxial zum äußeren Leiter (23) erstreckenden Durchgang (31), der innere Leiter (22) in den Durchgang (21) im Glaskörper (13) unter Ausbildung eines Überstandes (26) eingeführt wird, der Glaskörper (13) in die äußere Aufnahme (19) des metallischen Stopfens (12) eingefügt wird, das Ensemble die hermetische Abdichtung zwischen dem metallischen Stopfen (12) und dem Glaskörper (13) einerseits sowie dem Glaskörper (13) und dem sich durch ihn erstreckenden Bereich (25) des inneren Leiters (22) andererseits hervorrufender Erwärmung ausgesetzt wird, die Freiflächen des metallischen Stopfens (12) und des inneren Leiters (22) mit lötbarem Material plattiert werden, das vom Glaskörper (13) abgekehrte Ende des inneren Leiters (22) in den Durchgang (31) im äußeren Leiter (23) unter Ausbildung eines endseitigen Überstandes (29) eingeführt wird und der Endbereich (33) des äußeren Leiters (23) mit dem metallischen Stopfen (12) leitend verbunden wird (32). 25 30 35 40 45 50 55

