

PATENT SPECIFICATION

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(54) OPTOELECTRONIC COUPLER

(71) We, TOKYO SHIBAURA ELECTRIC COMPANY LIMITED, a Japanese corporation, of 72 Horikawa-cho, Saiwai-ku, Kawasaki-shi, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

The present invention relates to an optoelectronic coupler.

Optoelectronic couplers have been known as an optoelectronic transducer with a light emitting element and a light detecting element which are optically coupled to each other but electrically isolated from each other. Of them, DIP type couplers, because of their properties, have been widely used as coupling elements in logic circuits, analog relays, motor controls and so on.

Of various electrical characteristics of the optoelectronic couplers, the optoelectronic conversion efficiency and the input-to-output conversion efficiency are most important, and many attempts have been made to improve these characteristics. However, in order to improve the electrical characteristics of the optoelectronic couplers, the following problems must be solved so that so far no satisfactory result has been attained yet:

(1) With decrease in distance between the light emitting and detecting elements, the conversion efficiencies may be increased accordingly, but the breakdown voltage between the input or light emitting element and the output or the light detecting element is decreased,

(2) With the use of a light emitting element capable of producing a high optical output, the conversion efficiencies may be increased, but this results in inevitable increase in cost,

(3) In like manner with the use of a light detecting element which is highly sensitive the conversion efficiencies may be improved, but this results in increase in cost as well as leakage current or dark current.

Furthermore, in order to provide optoelectronic couplers with a conversion efficiency within a predetermined range, they

must be fabricated with a higher degree of accuracy and the improvement of the conversion efficiency is greatly dependent upon how accurately the components are fabricated and assembled so that the reduction in rejection ratio; that is, the increase in yield has been a very difficult problem.

An object of the present invention is to provide an optoelectronic coupler which is very simple in construction and inexpensive to manufacture yet exhibits very satisfactory conversion efficiency and has a breakdown voltage within a predetermined range.

According to the present invention there is provided an optoelectronic coupler comprising: a first base, a light-emitting element mounted on said first base, at least one output lead extending through said first base and electrically connected to said light-emitting element, a second base, a light-detecting element disposed in opposed relation with said light-emitting element and mounted on said second base, at least one output lead extending through said second base and electrically connected to said light-detecting element, a light propagation space defined between said light-emitting and light-detecting elements, a casing which encloses said light-emitting and light-detecting elements, and a highly reflective and highly electrically insulating isolation wall formed so as to surround said light propagation space.

The present invention can provide an optoelectronic coupler the desired electrical characteristics of which are independent of the configuration and dimensions of the light propagation space or path so that the manufacture may be much facilitated.

Embodiments of the present invention will now be described with reference to the accompanying drawings in which:—

Figure 1 is a schematic sectional view of an optoelectronic coupler in accordance with the present invention; and

Figure 2 shows a modification of the embodiment shown in Figure 1.

Same reference numerals are used to designate similar parts throughout the Figures.

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In Figure 1 there is shown a first optoelectronic coupler in accordance with the present invention. A monochromatic-light emitting element 1 capable of emitting near-infrared rays and consisting of, for example, a gallium-arsenide based pellet is disposed in opposed relation with a highly sensitive light detecting element 2. A pair of leads 3 are electrically connected to the light emitting element 1 while a pair of output leads are connected to the light detecting element 2. The space between the light emitting and detecting elements 1 and 2 which defines a light propagation path is filled with a transparent material 5 such as silicone resin. The optoelectronic coupler has cylindrical outer walls 8 of metal and is therefore generally called "metal type". A light emitting section 10 consists of the light emitting element 1 mounted on a base 9 and of a part of the transparent material 5 and a light detecting section 12 consists of the light detecting element 2 mounted on a base 11 and of the other part of the transparent material 5. The light emitting and detecting sections 10 and 11 are separately fabricated and are securely joined to each other as shown in Figure 1.

Optical isolation walls 7 are interposed between the transparent material 5 which defines the light propagation path and the metallic walls 8 when the light emitting and detecting sections 10 and 12 are fabricated. The isolation walls 7 are opaque and have a high reflectivity so that a higher efficiency may be ensured in transmission of light from the light emitting element 1 to the light detecting element 2. The isolation walls 7 are formed by coating or spraying a mixture consisting of a coloured pigment (generally a white pigment), a filler and a vehicle, over the outer surfaces of the transparent material 5. More particularly, the isolation wall 7 must be made of a material which not only exhibits a high reflectivity, a high electrical insulation and a high resistance to light but also is chemically stable with silicone or other material of which is made the transparent material 5 and with epoxy resin or other material of which is made the isolation wall 7. For instance, the material of the isolation wall 7 may consist of titanium oxide or zinc oxide as a white pigment, titanium oxide or zinc oxide as a filler and silicone oil or silicone resin as a vehicle.

A modification of the first embodiment shown in Figure 1 is shown in Figure 2, and is generally called "ceramic type". At its name implies, an internal structure or assembly is encapsulated in a ceramic tube 13. The coupler consists of a light emitting section 14 in which the light emitting element 1 is mounted on the base 9 and is encapsulated in the transparent material 5, and a light detecting section 15 in which the light detecting element 2 is mounted on the base 11 and

is encapsulated in the transparent material 5. In production, the light emitting and detecting sections 14 and 15 are fabricated separately, and assembled together such that the light emitting and detecting elements 1 and 2 are opposed to each other in the ceramic tube 13. Both the transparent materials are in the form of a convergent lens so that the higher light transmission efficiency may be ensured. Furthermore, the highly reflective isolation wall 7 is formed within the light propagation space within the ceramic tube 13 between the light emitting and detecting sections 14 and 15 over the inner wall surface of the ceramic tube 13 so that almost all of light emitted from the light emitting element 1 may be incident into the light detecting element 2.

With the above constructions of optoelectronic couplers in accordance with the present invention, the light emitted from the light emitting element 1 is subjected to diffuse reflection by the highly reflective isolation wall 7 and is transmitted through the transparent material 5, constituting the space of light path, and as a result is for the most part incident into the light detecting element 2. Consequently, the conversion efficiency, that is, the ratio of the input to the output, may be considerably improved to almost twice as compared with the prior art couplers. In case of the optoelectronic couplers which may have a conversion efficiency within a predetermined range, the conversion efficiency is almost independent of the light propagation path, that is, the configuration and length of the propagation path. Therefore they may be fabricated with a lesser degree of accuracy so that the production steps may be much facilitated and consequently the rejection ratio may be decreased by about 20% as compared with the prior art.

Each illustrated embodiment of the present invention is an optoelectronic coupler which is extremely simple in construction and manufacture yet has a high conversion efficiency.

WHAT WE CLAIM IS:—

1. An optoelectronic coupler comprising: a first base, a light-emitting element mounted on said first base, at least one input lead extending through said first base and electrically connected to said light-emitting element, a second base, a light-detecting element disposed in opposed relation with said light-emitting element and mounted on said second base, at least one output lead extending through said second base and electrically connected to said light-detecting element, a light propagation space defined between said light-emitting and light-detecting elements, a casing which encloses said light-emitting and light-detecting elements, and a

In Figure 1 there is shown a first optoelectronic coupler in accordance with the present invention. A monochromatic-light emitting element 1 capable of emitting near-infrared rays and consisting of, for example, a gallium-arsenide based pellet is disposed in opposed relation with a highly sensitive light detecting element 2. A pair of leads 3 are electrically connected to the light emitting element 1 while a pair of output leads are connected to the light detecting element 2. The space between the light emitting and detecting elements 1 and 2 which defines a light propagation path is filled with a transparent material 5 such as silicone resin. The optoelectronic coupler has cylindrical outer walls 8 of metal and is therefore generally called "metal type". A light emitting section 10 consists of the light emitting element 1 mounted on a base 9 and of a part of the transparent material 5 and a light detecting section 12 consists of the light detecting element 2 mounted on a base 11 and of the other part of the transparent material 5. The light emitting and detecting sections 10 and 11 are separately fabricated and are securely joined to each other as shown in Figure 1.

Optical isolation walls 7 are interposed between the transparent material 5 which defines the light propagation path and the metallic walls 8 when the light emitting and detecting sections 10 and 12 are fabricated. The isolation walls 7 are opaque and have a high reflectivity so that a higher efficiency may be ensured in transmission of light from the light emitting element 1 to the light detecting element 2. The isolation walls 7 are formed by coating or spraying a mixture consisting of a coloured pigment (generally a white pigment), a filler and a vehicle, over the outer surfaces of the transparent material 5. More particularly, the isolation wall 7 must be made of a material which not only exhibits a high reflectivity, a high electrical insulation and a high resistance to light but also is chemically stable with silicone or other material of which is made the transparent material 5 and with epoxy resin or other material of which is made the isolation wall 7. For instance, the material of the isolation wall 7 may consist of titanium oxide or zinc oxide as a white pigment, titanium oxide or zinc oxide as a filler and silicone oil or silicone resin as a vehicle.

A modification of the first embodiment shown in Figure 1 is shown in Figure 2, and is generally called "ceramic type". At its name implies, an internal structure or assembly is encapsulated in a ceramic tube 13. The coupler consists of a light emitting section 14 in which the light emitting element 1 is mounted on the base 9 and is encapsulated in the transparent material 5, and a light detecting section 15 in which the light detecting element 2 is mounted on the base 11 and

is encapsulated in the transparent material 5. In production, the light emitting and detecting sections 14 and 15 are fabricated separately, and assembled together such that the light emitting and detecting elements 1 and 2 are opposed to each other in the ceramic tube 13. Both the transparent materials are in the form of a convergent lens so that the higher light transmission efficiency may be ensured. Furthermore, the highly reflective isolation wall 7 is formed within the light propagation space within the ceramic tube 13 between the light emitting and detecting sections 14 and 15 over the inner wall surface of the ceramic tube 13 so that almost all of light emitted from the light emitting element 1 may be incident into the light detecting element 2.

With the above constructions of optoelectronic couplers in accordance with the present invention, the light emitted from the light emitting element 1 is subjected to diffuse reflection by the highly reflective isolation wall 7 and is transmitted through the transparent material 5, constituting the space of light path, and as a result is for the most part incident into the light detecting element 2. Consequently, the conversion efficiency, that is, the ratio of the input to the output, may be considerably improved to almost twice as compared with the prior art couplers. In case of the optoelectronic couplers which may have a conversion efficiency within a predetermined range, the conversion efficiency is almost independent of the light propagation path, that is, the configuration and length of the propagation path. Therefore they may be fabricated with a lesser degree of accuracy so that the production steps may be much facilitated and consequently the rejection ratio may be decreased by about 20% as compared with the prior art.

Each illustrated embodiment of the present invention is an optoelectronic coupler which is extremely simple in construction and manufacture yet has a high conversion efficiency.

WHAT WE CLAIM IS:—

1. An optoelectronic coupler comprising: a first base, a light-emitting element mounted on said first base, at least one input lead extending through said first base and electrically connected to said light-emitting element, a second base, a light-detecting element disposed in opposed relation with said light-emitting element and mounted on said second base, at least one output lead extending through said second base and electrically connected to said light-detecting element, a light propagation space defined between said light-emitting and light-detecting elements, a casing which encloses said light-emitting and light-detecting elements, and a



highly reflective and highly electrically insulating isolation wall formed so as to surround said light propagation space.

5 2. An optoelectronic coupler according to claim 1 wherein said light propagation space is filled with material which is light-transparent as well as electrically insulating.

10 3. An optoelectronic coupler according to claim 1 wherein said light-emitting and light-detecting elements are embedded and securely held in position in said casing.

15 4. An optoelectronic coupler according to claim 1 wherein said casing is cylindrical and metallic, said first and second bases are fitted into and securely held in said cylindrical casing in such a way that said light-emitting and light-detecting elements are in opposed relation; and said isolation wall is formed over the inner wall of said cylindrical casing.

20 5. An optoelectronic coupler according to claim 1 wherein said light-emitting and light-detecting elements are each covered with means for increasing the light transmission efficiency between said light-emitting element and said light-detecting element.

25 6. The optoelectronic coupler according to claim 5 wherein said means comprise two convergent lenses of light-transparent as well as highly electrically insulating material, one lens covers said light-emitting element and the

other lens covers said light-detecting element, so as to oppose each other.

35 7. An optoelectronic coupler according to claim 5 wherein said casing is formed as a ceramic tube, said isolation wall is formed over the inner wall surface of said tube, and said first and second bases with said light-emitting and light-detecting elements mounted thereon, respectively, are fitted into and securely held in said ceramic tube in such a way that said light-emitting and light-detecting elements are disposed in opposed relation.

40 8. An optoelectronic coupler according to claim 1 wherein two input leads extend through said first base and are electrically connected to said light-emitting element and two output leads extend through said second base and are electrically connected to said light-detecting element.

45 9. An optoelectronic coupler according to claim 7 wherein two input leads extend through said first base and are electrically connected to said light-emitting element and two output leads extend through said second base and are electrically connected to said light-detecting element.

50 10. An optoelectronic coupler, substantially as hereinbefore described with reference to the accompanying drawings.

MARKS & CLERK.



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