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(54) Benævnelse: **Sensoranordning**

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JP-A- 61 134 082
US-A- 4 752 799
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The present invention relates to a sensor arrangement, in particular as part of a reflection light barrier, comprising a carrier on which a photodiode, a first light emitting diode for emitting a measuring light beam, in particular a pulsed measuring light beam, a second light emitting diode for emitting a reference light beam, in particular a reference light beam pulsed offset in time with respect to the measuring light beam, and a light permeable housing enclosing the photodiode and the two light emitting diodes are arranged.

In a known sensor arrangement for reflection light barriers of this type, two LED chips and one photodiode chip are arranged on a circuit board. The LED chip provided for emitting the reference light beam directly irradiates the adjacent photodiode, with a large part of the light being radiated into the side surface of the photodiode due to the position of both chips on one plane. The other LED chip provided for emitting the useful light beam, in contrast, only radiates upwardly since it is located in a separate part of the housing. If a reflecting object is located in its beam cone, the reflected light is incident on the photodiode from above.

On the irradiation of a photodiode with a light pulse, the photo current resulting from the irradiation of the photodiode follows the light pulse with a specific delay which is quantified by the rise time and the decay time of the photo current. These times generally depend both on the electrical parameters of the photodiode, above all on its capacity, and on its external electrical wiring, essentially on the load resistance. There is furthermore, however, a clear dependence on the direction of the optical radiation. If the light is not incident on the semiconductor chip primarily from above, but penetrates into the chip through the side surfaces, a considerable increase in the rise time and decay time occurs. The photodiode therefore becomes slower. The reason for this is probably the following: with lateral radiation, a large portion of the production of free charge carrier pairs caused by absorption of the light takes place in the substrate of the chip. Before these charge

carrier pairs can contribute to an electrical current, they must first diffuse into the region of the p-n junction, which results in a delay.

In the specific application, both LED chips are operated in an alternately pulsed manner, whereby the sensitivity to environmental light of the reflection light barrier can be eliminated with the help of an electronic circuit. The different time behavior for the light radiation onto the photodiode from the side or from above causes major problems for the evaluation electronics in this process.

A sensor arrangement having the features of the preamble of claim 1 is known from US 4 752 799 A.

Further sensor arrangements which have a photodiode, a first light emitting diode and a second light emitting diode are known from US 5 103 085 A and US 2003/0189618 A1.

The problems explained above are solved by a sensor arrangement having the features of claim 1. The solution accordingly comprises a sensor arrangement, in particular as part of a reflection light barrier, comprising a carrier on which a photodiode, a first light emitting diode for emitting a measuring light beam, in particular a pulsed measuring light beam, a second light emitting diode for emitting a reference light beam, in particular a reference light beam pulsed offset in time with respect to the measuring light beam, and a light permeable housing enclosing the photodiode and the two light emitting diodes are arranged, which sensor arrangement is characterized in that the second light emitting diode is arranged on the carrier such that the reference light emitted by it is essentially not laterally incident on the photodiode.

The reference light emitted by the second light emitting diode is therefore essentially only incident on the photodiode along an indirect reference light path.

The reference light emitted by the second light emitting diode is in this respect essentially incident on the photodiode due to reflection at the wall of the housing, with this reflection being based on a total reflection.

In accordance with a particularly preferred embodiment of the invention, the photodiode is arranged on a first plane of the carrier and the second light emitting diode serving for the radiation of the reference light is arranged on a second plane. This is particularly simple in manufacture and is in particular already solely sufficient to largely avoid a lateral radiation of reference light into the photodiode when the two planes are offset with respect to one another at least by the height of the photodiode or of the second light emitting diode. The radiation of reference light onto the photodiode can thereby only take place via reflection at the walls of the housing such that the radiation onto the photodiode essentially takes place from above.

The second light emitting diode is preferably arranged on a higher plane than the photodiode. Generally, however, the arrangement could also be reversed.

A circuit board is in particular provided as the carrier, with the circuit board preferably being formed in the manner of a sandwich board of at least two layers. This is also again simple and cost favorable in manufacture. The manufacture of the layers in particular takes place by lamination.

It is moreover particularly preferred for the carrier to consist of a material impermeable to light. Other irritating radiations onto the photodiode can thus also be prevented.

The housing is preferably formed by an encapsulant composed of a material permeable to light such as epoxy resin. This material has been found to be

particularly suitable to ensure both a transmission of the measuring light to an object to be detected and a reflection of the reference light at the housing.

The housing can preferably be chamfered in the region of the second light emitting diode for the improvement of the reflection at the walls of the housing and for the prevention of a detection of an object by the reference light. On the other hand, a lens for focusing the measuring light in the direction of a possible object to be detected is preferably provided in front of the first light emitting diode.

An embodiment of the invention is represented in the drawing and will be described in the following. There is shown as the only Figure in a schematic representation

Fig. 1 a cross-section through a sensor arrangement in accordance with the invention.

The sensor arrangement shown comprises a circuit board 1 as the carrier comprising a first layer 1a and a second layer 1b which is laminated onto it, but only covers part of the first layer 1a. Two planes 2a and 2b are thereby formed for the carrier.

A photodiode 3 and a first light emitting diode 4 are arranged next to one another on the first plane 2a, while a second light emitting diode 5 is provided on the second plane 2b. The photodiode 3 is located directly next to the second layer 1b of the carrier 1 and the height of the second layer 1b is selected to be somewhat larger than the height of the photodiode 3. The first light emitting diode 4 is located spaced apart on the side of the photodiode 3 remote from the second light emitting diode 5.

An encapsulant composed of an epoxy resin is applied to the circuit board 1 and forms a housing 6 which receives the photodiode 3 and the two light emitting diodes 4 and 5. The first light emitting diode 4 is located in this process in a separate region of the housing 6 which is separated by a crosstalk barrier, not shown here, from the photodiode 3 and from the second light emitting diode 5 such that light emitted by the first light emitting diode 4 cannot be laterally incident on the photodiode 3. A lens, likewise not shown here, is moreover arranged in front of the first light emitting diode 4. On the other side, the housing 6 is formed with a chamfered surface 7, a so-called facet, in the region of the second light emitting diode 5.

The first light emitting diode 4 serves for the production of measuring light which exits the housing 6 and is reflected by an object 8 located in front of the housing 6. The measuring light emitted by the first light emitting diode 4 thereby arrives at the upper side 3a of the photodiode 3 in accordance with the arrows I and II and produces an electrical signal in it. The light emitting diode 4 is operated in a clocked manner in this process.

The second light emitting diode 5 is activated offset in time with respect to it. Said second light emitting diode 5 transmits a reference light beam which is reflected at the walls of the housing 6 such that it is reflected onto the upper side 3a of the photodiode 3 in accordance with the arrows III and IV. The environmental light can be calculated out by subtraction of the two signals. In addition, the reference light signal produced by the second light emitting diode 5 can be used for a regulation.

As can be seen, the arrangement of the second light emitting diode 5 on the second plane 2b formed by the second layer 1b of the carrier board 1 prevents a lateral radiation of reference light into the photodiode 3. The reference light, like the reflected measuring light, therefore essentially only radiates onto the photodiode 3 from above. The time behavior of the reference light signal thus

corresponds to that of the measuring light signal in the photodiode 3, whereby the initially described problems are avoided. Low rise times and decay times of the photodiode 3 can in particular also be achieved with respect to the reference light in this manner.

Other misguided light can also largely be excluded by forming the two layers 1a and 1b of the carrier board 1 from a material impermeable to light.

Reference numeral list

1	carrier board
1a	first layer of 1
1b	second layer of 1
2a	first plane
2b	second plane
3	photodiode
3a	upper side of 3
4	first light emitting diode
5	second light emitting diode
6	housing
7	facet
8	object
I	beam direction
II	beam direction
III	beam direction
IV	beam direction
h	height of 3

Patentkrav

1. Sensoranordning, særligt som del af en refleksionsfotocelle, med en bæreplade (1), på hvilken der er anbragt en fotodiode (3), en første lysdiode (4) til udsendelse af en pulseret målelysstråle og en anden lysdiode (5) til udsendelse af en pulseret referencelysstråle, som er tidsforskudt i forhold til målelysstrålen samt et lysgennemtrængeligt hus (6), der omslutter fotodioden (3) og de to lysdioder (4, 5), hvor den anden lysdiode (5) er anbragt sådan på bærepladen (1), at det fra denne udsendte referencelys i det væsentlige ikke rammer siden af fotodioden (3),
kendetegnet ved, at referencelysstrålen udsendt fra den anden lysdiode (5) i det væsentlige rammer fotodioden (3) på grund af totalrefleksion på husets (6) væg.

2. Sensoranordning ifølge krav 1,
kendetegnet ved, at fotodioden (3) er anbragt på et første niveau (2a) af bærepladen (1), og den anden lysdiode (5) er anbragt på et andet niveau (2b) på bærepladen (1).

3. Sensoranordning ifølge krav 2,
kendetegnet ved, at de to niveauer (2a, 2b) er forskudt i forhold til hinanden med i det mindste hhv. højden (h) af fotodioden (3) eller højden af den anden lysdiode (5).

4. Sensoranordning ifølge krav 2 eller 3,
kendetegnet ved, at den anden lysdiode (5) i forhold til en stråleretning (III) for den udsendte referencelysstråle er anbragt på et højere niveau (2b) end fotodioden (3).

5. Sensoranordning ifølge et af de foregående krav, **kendetegnet ved, at** der som bæreplade (1) er tilvejebragt et printkort.

6. Sensoranordning ifølge krav 5,
kendetegnet ved, at printkortet (1) er udført som en type sandwich-printkort med mindst to lag.

7. Sensoranordning ifølge krav 6,
kendetegnet ved, at bæreprintkortets (1) lag (1a, 1b) er lamineret på hinanden.

8. Sensoranordning ifølge et af de foregående krav, **kendetegnet ved, at** bærepladen (1) består af et lystæt materiale.

9. Sensoranordning ifølge et af de foregående krav,
kendetegnet ved, at huset (6) er fremstillet af en indkapslingmasse af lysgennemtrængeligt materiale som epoxydharpiks.

10. Sensoranordning ifølge et af de foregående krav,
kendetegnet ved, at huset (6) i området med den anden lysdiode (5) er udformet med en skrå væg, nemlig en såkaldt facet (7).

11. Sensoranordning ifølge et af de foregående krav,
kendetegnet ved, at der foran den første lysdiode (4) er anbragt en linse til fokusering af det brugbare lys.

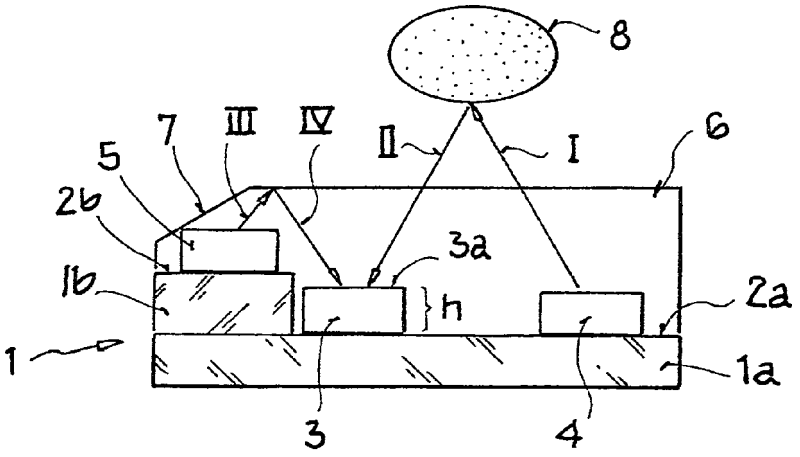

FIG.