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Datasheet for the decision of 10 September 2024

Case Number: T 1967/21 - 3.5.04

Application Number: 16739156.4

Publication Number: 3357233

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Language of the proceedings: EN

Title of invention:
METHOD FOR EXTENDING THE DYNAMIC RANGE OF A PIXEL DETECTOR SYSTEM USING AUTOMATIC GAIN SWITCHING

Applicant:
Paul Scherrer Institut

Headword:

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step - (no)

Decisions cited:

Catchword:

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Boards of Appeal

Chambres de recours

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Case Number: T 1967/21 - 3.5.04

D E C I S I O N
of Technical Board of Appeal 3.5.04
of 10 September 2024

Appellant: (Applicant)	Paul Scherrer Institut 5232 Villigen PSI (CH)
Representative:	Fischer, Michael Siemens AG Postfach 22 16 34 80506 München (DE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 15 July 2021 refusing European patent application No. 16739156.4 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chair	A. Seeger
Members:	B. Le Guen
	B. Müller

Summary of Facts and Submissions

I. The appeal is against the decision to refuse European patent application No. 16 739 156.4. The decision is a decision "according to the state of the file", as requested by the applicant by letter dated 2 July 2021. It refers to the examining division's communication dated 13 October 2020 for the reasons.

II. The documents cited in the examining division's communication included the following:

D1: US 2014/0166861 A1
D5: US 2010/0044552 A1

III. The examining division found *inter alia* that the subject-matter of claim 1 of the sole request then on file did not involve an inventive step (Article 56 EPC) in view of the combined disclosures of documents D1 and D5.

IV. The applicant (appellant) filed notice of appeal. With its statement of grounds of appeal, it maintained the request on which the decision under appeal was based, and provided arguments to support its view that the subject-matter of claim 1 involved an inventive step.

V. The appellant was summoned to oral proceedings. In a communication under Article 15(1) RPBA, the board provisionally confirmed the examining division's finding that the subject-matter of claim 1 of the sole request on file did not involve an inventive step in

view of the combined disclosures of documents D1 and D5.

VI. In a letter dated 5 August 2024, the appellant indicated that it would attend the oral proceedings but did not reply in substance to the board's preliminary opinion.

VII. The oral proceedings before the board took place on 10 September 2024. During the oral proceedings, the appellant referred to its written submissions.

The appellant's final request was that the decision under appeal be set aside and that a European patent be granted on the basis of the claims of the sole request which formed the basis for the decision under appeal.

At the end of the oral proceedings, the chair announced the board's decision.

VIII. Claim 1 of the sole request on file reads as follows:

"*A detector system (14), comprising:*
a) a layer of photosensitive material (4);
b) an N x M array of photo-detector diodes (2) arranged in said layer of photosensitive material (4); each of said photo-detector diodes (2) having a bias potential interface (12) and a diode output interface, said bias potential interface (12) of each photo-detector diode (2) being connected to a bias potential (V_{bias});
c) a N x M array of high gain, low noise readout unit cells (RO) being disposed below the plane of these photo-detector diodes (2) in form of a readout chip (16) having a corresponding number of readout unit cells RO for collecting the charge from the electron hole pairs (10) generated in the respective photo-

detector diodes (2) wherein the readout chip provides one readout unit cell (RO) for each photo-detector diode (2); and
d) each readout unit cell (RO) comprising:
d1) an input interface (IN) connecting said diode output interface to a high-gain charge-to-voltage amplifying means (34);
d2) said high-gain charge-to-voltage amplifying means (34) having a number of gains and being enabled to automatically switch between the gains,
d3) said number of gains being implemented by an array of integration capacitors (Cf1, Cf2, Cf3, ...) and being enabled to automatically switch between the gains,
d4) a comparator and digital block (30) for monitoring the charge of the selected integration capacitor and for switching the actual gain to another gain depending from the monitored charge of the selected integration capacitor."

Reasons for the Decision

1. The appeal is admissible.

A. Inventive step

2. An invention is to be considered as involving an inventive step if, having regard to the state of the art, it is not obvious to a person skilled in the art (Article 56 EPC).

A.1 Disclosure of document D1

3. Document D1 discloses a detector system (see D1, paragraph [0001]: "*single photon counting detector system*") comprising the following means:

a) a layer of photosensitive material (see D1, paragraph [0010]);

b) an N x M array of photo-detector diodes arranged in said layer of photosensitive material; each of said photo-detector diodes having a bias potential interface and a diode output interface, said bias potential interface of each photo-detector diode being connected to a bias potential (see D1, paragraph [0011]);

c) an N x M array of high gain, low noise readout unit cells (see D1, paragraph [0012]) being disposed below the plane of these photo-detector diodes in form of a readout chip having a corresponding number of readout unit cells RO for collecting the charge from the electron hole pairs generated in the respective photo-detector diodes wherein the readout chip provides one readout unit cell for each photo-detector diode (see D1, Figure 2 and paragraph [0031]: "*Below the plane of these photo-detector diodes 2 a readout chip 16 having a corresponding number of readout unit cells RO is arranged for collecting the charge from the electron hole pairs 10 generated in the respective photo-detector diodes 2.*"); and

d) each readout unit cell comprising:

d1) an input interface connecting said diode output interface to a high-gain charge-to-voltage amplifying means (see Figure 3, "*amp1*" and "*amp2*"; paragraph [0032]: "*The charge generated in the photo detector diode 2 by the x-ray is amplified by*

a low noise charge sensitive amplifier amp1 where the charge is integrated on the integration capacitance C_{int}. ... The amplifier amp2 then further amplifies the signal with a gain given by the ration [sic] *of C1/C2.*").

A.2 Distinguishing features

4. It is undisputed that the system of claim 1 differs from the system disclosed in document D1 by the fact that each readout unit cell also comprises the following features (see point 2 of the examining division's communication dated 13 October 2020 and page 1 of the statement of grounds of appeal):

d2) "*said high-gain charge-to-voltage amplifying means (34) having a number of gains and being enabled to automatically switch between the gains*",

d3) "*said number of gains being implemented by an array of integration capacitors (Cf1, Cf2, Cf3, ...) and being enabled to automatically switch between the gains*",

d4) "*a comparator and digital block (30) for monitoring the charge of the selected integration capacitor and for switching the actual gain to another gain depending from the monitored charge of the selected integration capacitor*".

5. On page 1 of the statement of grounds of appeal, the appellant submitted that document D1 did not disclose readout unit cells "*being disposed below the plane of these photo-detector diodes in form of a readout chip having a corresponding number of readout unit cells RO for collecting the charge from the electron hole pairs*

generated in the respective photo-detector diodes wherein the readout chip provides one readout unit cell for each photo-detector diode".

Since these features are disclosed almost verbatim in paragraph [0031] of document D1, the board understands the appellant's argument to be that document D1 does not disclose readout unit cells, each of which includes features d2), d3) and d4), disposed below the plane of the photo-detector diodes. The board agrees. However, this is equivalent to stating that the distinguishing features are features d2), d3) and d4), as found by the examining division.

A.3 Technical effect and objective technical problem

6. Features d2), d3) and d4) adapt the dynamic range of each pixel independently on the basis of the incoming photon flux (see application as filed, page 1, lines 15 and 16; page 5, lines 4 to 9; page 12, lines 3 to 17). Thus the board agrees with the examining division (see page 3 of the communication dated 13 October 2020) that the objective technical problem can be formulated as that of improving the dynamic-range performance of the detector system.

7. On page 1 of the statement of grounds of appeal, the appellant submitted the following: "*the objective of the present invention can be defined as to provide a compact detector system that can operate at a high incoming photon rates* [sic] *with a fast frame rate thereby also providing a high readout frame rate for the digital part of the readout units*".

Since claim 1 does not limit the number of components (for example, the number of integration capacitors) in

a readout unit cell and does not specify how the components are arranged in the readout unit, the board does not consider compactness a technical effect achieved by features d2), d3) and d4).

Nor does the board see how features d2), d3) and d4) have an impact on the frame rate. In fact, according to page 3 of the application at hand, lines 19 to 23, minor or no adjustments are made to the frame rate in the invention.

The board agrees with the appellant that the detector system "*can operate at a high incoming photon rates* [sic]" due to features d2), d3) and d4). However, in the context of this application, this is equivalent to stating that the detector's dynamic range can be adaptively increased.

A.4 Obviousness

8. Document D5 proposes a solution for adapting the dynamic range of a photo-detector on the basis of the photon flux (see D5, paragraphs [0008] to [0009] and [0020]). This solution relies on a circuit that comprises the following means:

d1) an input interface connecting a diode output interface to a high-gain charge-to-voltage amplifying means (see D5, Figure 1 and paragraph [0022]),

d2) said high-gain charge-to-voltage amplifying means having a number of gains and being enabled to automatically switch between the gains (see D5, paragraph [0023]),

d3) said number of gains being implemented by an array of integration capacitors and being enabled to automatically switch between the gains (see D5, paragraph [0023]),

d4) a comparator and digital block for monitoring the charge of the selected integration capacitor and for switching the actual gain to another gain depending from the monitored charge of the selected integration capacitor (see D5, paragraph [0024], last sentence).

9. In view of the objective technical problem, the skilled person would have implemented the solution disclosed in document D5 in each readout cell of the detector of document D1 and, in doing so, would have arrived at the subject-matter of claim 1.

10. In its statement of grounds of appeal, the appellant argued that document D5 did not disclose a gain switching ability at pixel level.

The board does not find this argument persuasive. The circuit disclosed in document D5 is replicated for and coupled to every pixel of the photo-detector array (see Figure 3). Moreover, the voltage V_{OUT}, on the basis of which the switch is automatically triggered (see paragraph [0024], last sentence), is pixel-dependent. In any case, paragraph [0021] states that the proposed solution is to "*provide very large instantaneous dynamic range for optical sensors, e.g.,* ***at the FPA unit cell level***" (emphasis added by the board). An FPA unit cell is defined in paragraph [0020] as a pixel. Thus document D5 clearly discloses a gain switching ability at pixel level.

11. On page 1 of its statement of grounds of appeal, the appellant further argued that "*the person skill* [sic] *in the art did not expect at the time of filing the application to be able to provide the digital part of the readout unit per cell (pixel) below the surface of the detector chip which is not larger than the resolution of the detector given by the size of the photo-detector diodes (typically in the range of 50x50 um^2)*".

The board notes that a high standard of proof is required to demonstrate a technical prejudice (see Case Law of the Boards of Appeal of the European Patent Office, 10th edition, 2022, I.D.10.2). There is no evidence on file supporting the appellant's allegation.

Document D1 teaches placing the readout unit cell below each photo-detector diode (see Figure 2 and paragraph [0031]). Thus, as indicated by the examining division (see page 4 of the communication dated 13 October 2020), document D1 directly contradicts the appellant's allegation. Embedding the circuit disclosed in document D5 in the readout unit cell under the photo-detector diode of document D1 would have been an obvious way of modifying the detector of document D1.

For the sake of completeness, the board notes that since claim 1 does not limit the number of electronic components of a readout unit cell, it does not limit the area occupied by that cell. The fact that the readout unit cells are disposed below the plane of photo-detector diodes does not mean that the area occupied by a readout unit cell is smaller than or equal to that occupied by the corresponding photo-detector diode. Thus any argument relying on the size of the readout unit cell must fail.

12. In view of the above, the board agrees with the examining division that the subject-matter of claim 1 does not involve an inventive step in view of the disclosure of document D1 combined with the disclosure of document D5.

B. Conclusion

13. Since the sole request on file is not allowable, the appeal must be dismissed.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chair:

K. Boelicke A. Seeger

Decision electronically authenticated