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(54) Title: SPAD DETECTOR HAVING MODULATED SENSITIVITY

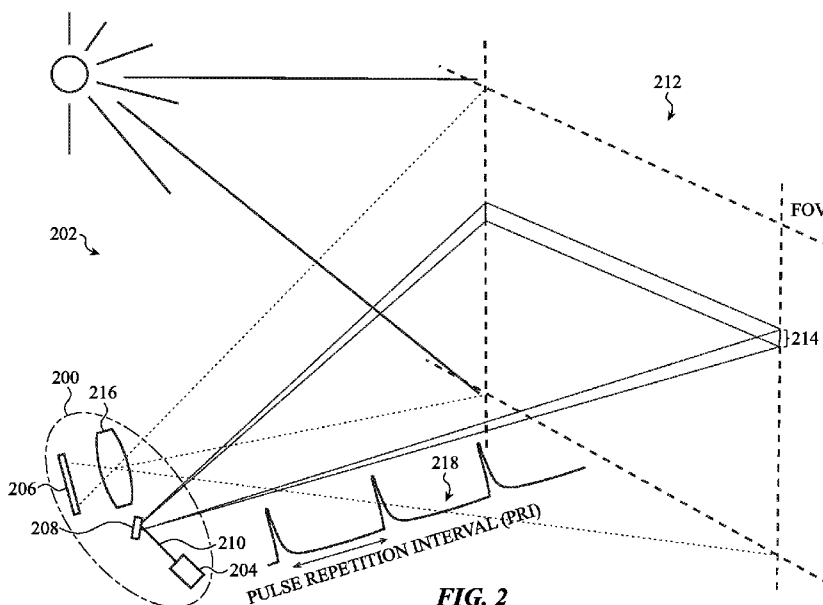


FIG. 2

(57) Abstract: The sensitivity of one or more single-photon avalanche diodes (SPAD) in a SPAD detector is modulated over time. The sensitivity of all of the SPADs may be modulated, or the sensitivity of one section of the SPADs can be modulated differently from another section of the SPADs. Various techniques for modulating the sensitivity are disclosed.



**Published:**

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

**(88) Date of publication of the international search report:**

27 September 2018 (27.09.2018)

**INTERNATIONAL SEARCH REPORT**

International application No  
PCT/US2018/015082

**A. CLASSIFICATION OF SUBJECT MATTER**  
INV. G01S17/08 G01S17/89 G01S7/486  
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
G01S H01L G01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, INSPEC, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2013/099101 A1 (CAMPBELL COLIN [GB]) 25 April 2013 (2013-04-25) paragraphs [0017], [0018], [0078], [0093] - [0096], [0101], [0107], [0110] - [0120]; figures 10A, 10B -----	1-5,9
X	US 2015/041625 A1 (DUTTON NEALE [GB] ET AL) 12 February 2015 (2015-02-12)	1-5,9, 11,12
Y	paragraphs [0033], [0077], [0084], [0089]; figures 10,16,17,18,20 -----	6-8,10
X	JP 2014 081254 A (TOYOTA CENTRAL RES & DEV) 8 May 2014 (2014-05-08)	1-5,9,13
Y	paragraphs [0020], [0030], [0060], [0061]; figures 1, 3, 6, 7, 13 -----	6-8,10
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Further documents are listed in the continuation of Box C.

See patent family annex.

\* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

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Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No  
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2015/285625 A1 (DEANE PETER [US]) 8 October 2015 (2015-10-08)	6-8
A	paragraphs [0065], [0076], [0087], [0089]; figure 2 -----	16-18
A	US 2013/175435 A1 (DRADER MARC [FR]) 11 July 2013 (2013-07-11) figures 1, 6A-6E -----	1-9
X	US 2013/300838 A1 (BOROWSKI ANDRE [CH]) 14 November 2013 (2013-11-14)	14-18
Y	paragraphs [0209], [0213]; figure 10 -----	10
X	US 2014/124653 A1 (DUTTON NEALE [GB] ET AL) 8 May 2014 (2014-05-08)	14-18
Y	paragraph [0025]; figures 1,5 -----	10
A	US 2012/162632 A1 (DUTTON NEALE [GB]) 28 June 2012 (2012-06-28) figures 1, 3 -----	12
A	DE 10 2010 060527 B3 (PICOQUANT GMBH [DE]) 19 April 2012 (2012-04-19) paragraphs [0006], [0033]; figure 1 -----	16-18

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US2018/015082

## Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3.  Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:  
  
1-18
4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

### Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

**FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210**

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-9

Reduction of the power consumption in a pixel array.

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2. claims: 10-18

Control of the activation of a pixel in a SPAD detector.

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3. claims: 19-23

Selection and control of an array of pixels in a SPAD detector

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2018/015082

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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