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Datasheet for the decision of 11 October 2019

Case Number: T 0485/14 - 3.4.01

Application Number: 08021165.9

Publication Number: 2068163

IPC: G01R33/06, G01R33/07, G01R33/00

Language of the proceedings: EN

Title of invention:
Hall sensor array

Patent Proprietor:
Melexis Technologies NV

Opponent:
ams AG

Headword:
Hall sensor/MELEXIS

Relevant legal provisions:
EPC Art. 56, 84, 123(2)
RPBA Art. 13(1)

Keyword:
Inventive step - (yes)
Amendments - allowable (yes)
Late-filed request - justification for late filing (yes)

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Boards of Appeal

Chambres de recours

Boards of Appeal of the
European Patent Office
Richard-Reitzner-Allee 8
85540 Haar
GERMANY
Tel. +49 (0)89 2399-0
Fax +49 (0)89 2399-4465

Case Number: T 0485/14 - 3.4.01

D E C I S I O N
of Technical Board of Appeal 3.4.01
of 11 October 2019

Appellant: (Opponent)	ams AG Schloss Premstätten Tobelbader Strasse 30 8141 Premstätten (AT)
Representative:	Epping - Hermann - Fischer Patentanwaltsgesellschaft mbH Schloßschmidstraße 5 80639 München (DE)
Respondent: (Patent Proprietor)	Melexis Technologies NV Transportstraat 1 3980 Tessenderlo (BE)
Representative:	Falk, Urs Patentanwaltsbüro Dr. Urs Falk Eichholzweg 9A 6312 Steinhausen (CH)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 19 December 2013 concerning maintenance of the European Patent No. 2068163 in amended form.**

Composition of the Board:

Chairman	P. Scriven
Members:	B. Noll
	D. Rogers

Summary of Facts and Submissions

I. With an interlocutory decision, the opposition division decided that the patent in the text of a *second auxiliary request* met the requirements of the Convention.

II. Claim 1 of this request reads:

> *A Hall sensor array comprising a single pair of Hall elements for use in a two-phase measurement cycle, each of the Hall elements comprising a square plate having two pairs of opposing contacts in the corners of the square plate, the pairs of opposing contacts being arranged such that their respective axes are substantially perpendicular, wherein said Hall elements of said pair are arranged diagonally in opposite quadrants of a square which describes said Hall sensor array, characterised in that the other two diagonally opposite quadrants of the square do not contain a Hall element and that the array is configured such that the respective axes of the pair of opposing contacts used at any given time to bias each of the Hall elements are perpendicular.*

III. The opponent appealed, and argued that

- the second auxiliary request should not have been admitted in view of Rule 137(5) EPC, because it related to subject-matter which had not been searched,
- the request should not have been admitted by the opposition division because it was late filed,

- the claims did not comply with Article 123(2) EPC due to the feature "square plate", and

- the claimed subject-matter lacked novelty having regard to

E3: EP 0 548 391 A1

and lacked inventive step having regard to

E1: WO 01/188556 A1.

IV. The proprietor did not appeal. The opponent is, therefore, the sole appellant; the proprietor is respondent.

V. In a communication accompanying a summons to oral proceedings, the Board set out its preliminary opinion on the case. The Board considered that there was no reason retrospectively not to admit the second auxiliary request, and that the wording "square plate" did not introduce a non-compliance with Article 123(2) EPC. The Board, however, considered that claim 1 did not comply with Articles 123(2) and (3) EPC for other reasons. Further, the Board noted that the document

E2: R.S. Popovic, "*Hall Effect Devices*", second Edition, Taylor & Francis (2003), chapter 5.6.3 "Reducing offset and 1/f noise"

should be considered for the question of patentability.

VI. At the oral proceedings held on 11 October 2019, the proprietor submitted a request headed *New main request* and a series of auxiliary requests. Finally, however, only the "New main request" remained and the respondent's final request was that the decision under appeal be set aside and that the patent be maintained on the basis of claims 1 to 3 of the *New main request*, filed at the oral proceedings before the Board on 11 October 2019.

VII. The appellant requested that the decision under appeal be set aside and the patent be revoked.

VIII. At the end of the oral proceedings, the Chairman announced the Board's decision.

IX. Claim 1 of the "New main request" reads (feature numbering by the Board):

A Hall sensor array comprising
(1) a single pair of Hall elements for use in a two-phase measurement cycle,
(2) each of the Hall elements comprising a square plate having two pairs of opposing contacts in the corners of the square

plate,
(3) the pairs of opposing contacts being arranged such that their respective axes are substantially perpendicular,
wherein
(4) said square plates of said pair are arranged in diagonally opposite quadrants of a square which describes said Hall sensor array and at opposite corners of said square,
characterised in that
(5) each Hall element takes up substantially a whole quadrant of the array area,
that
(6) the other two diagonally opposite quadrants of the square do not contain a Hall element
and that
(7) the array is configured such that the respective axes of the pair of opposing contacts used at any given time to bias each of the Hall elements of the pair are perpendicular.

X. Claim 3 defines a corresponding method.

Reasons for the Decision

Technical background

1. The patent relates to Hall sensors. A Hall sensor detects a magnetic field by making use of the well-known "Hall-effect", which is that an electrical voltage is induced perpendicular to the direction of current flow in a conductive plate, in the presence of a magnetic field that is also perpendicular to the current.

2. Ideally, the Hall voltage is proportional to the product of the current and the permeating magnetic field. However, in a practical Hall sensor, integrated as a conductive plate on a semiconductor substrate and having contacts for supplying current and for tapping the Hall voltage, a voltage offset may occur. This results in the voltage at the tapping contacts being different from zero even in the absence of a current and magnetic field.

3. In the prior art, various concepts are known for eliminating an offset in a Hall sensor. One approach is to arrange two or four Hall elements close together, so that individual offsets cancel out (*offset reduction by pairing*, cf. E2, page 284). Another approach is cyclically to commutate, or to alternate pairwise, the contacts for current injection and for tapping the Hall voltage in successive phases of a measurement cycle; this approach is commonly referred to as the *spinning-current technique* (E2, loc. cit.).

4. The patent in suit specifically aims at minimizing thermally generate offset, i.e. an offset caused by the Seebeck effect, which occurs when the Hall elements heat up, and heat one another, due to the flow of current (cf. paragraph 1 of the patent specification).

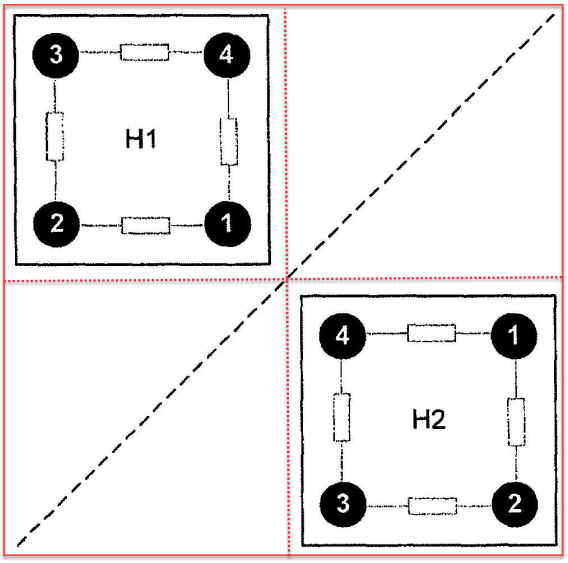
This aim is to be achieved under the additional condition that the number of phases in a single *spinning-current* measurement cycle is limited to two (cf. paragraph 13 of the patent specification).

The New main request - admissibility

5. The Board admitted the *New main request,* in exercise of its discretion under Article 13(1) RPBA 2007. The Board considered this request to be a serious attempt at overcoming objections raised, for the first time, in the Board's communication. Further, it did not give rise to new objections and dealing with it at oral proceedings was not an undue burden on the parties or the Board.

Amendments - Article 84 EPC

6. The Board is satisfied that the amendments comply with Article 84 EPC. Features (2) to (6) define a Hall sensor in which the Hall elements are arranged as shown in the figure below, which reproduces Figure 2 of the patent. By arranging the Hall elements such that each takes up substantially one quadrant of a square, which is the area of the sensor array, there is a pair of corners close together (1 of H1 and 4 of H2).



Amendments - Article 123(2) EPC

7. Claim 1 is based on claims 1, 2, and 4, and on paragraphs 15 and 18 of the published application.

8. The opponent argued that the application as filed did not directly and unambiguously disclose that the Hall element comprises a square plate. Hall elements were shown as a square shape only in Figure 2, which would be understood by the skilled person as being only a schematic circuit diagram of a Wheatstone-bridge, circumscribed by a square-shaped line. The skilled person would not, directly and unambiguously, derive from this figure the form of a Hall element as a square plate. Further, it was commonly known to the skilled person that a Hall element might have other shapes than square, e.g. cross-shaped or circular.

9. Contrary to the opponent's view, the application does, in the Board's judgment, directly and unambiguously disclose a Hall element as a square plate, when considering Figure 2 in connection with paragraph 15 of

the application (paragraph 17 of the patent), which reads:

> *Turning now to figure 2, a Hall sensor array according to the present invention is shown. In this sensor, the Hall elements H1 and H2 are arranged at diagonally opposed quadrants of a two by two array. In this array, as is usual, the pairs of opposing contacts used for biasing on each Hall element at any one time have perpendicular axes. Additionally in this array, the adjacent corners of both Hall elements are biased by the same polarity during the different phases as is set out in table 2.*

10. The skilled person would understand that the Hall elements are not only shown as schematic circuits. The skilled person, knowing that Hall elements for use in a two-phase measurement cycle arrangement are intrinsically equal in shape and rotationally symmetric (see e.g. E3, column 5, lines 5 to 9), would directly and unambiguously derive, from figure 2 and paragraph 15, that the Hall elements are square-shaped, with contacts arranged at the corners, such that rotating the Hall element by 90° would map it onto itself.

Amendments - reformatio in peius

11. The *New main request* does not adversely affect the appellant's position in relation to the *second auxiliary request*, which was held allowable by the opposition division. Claim 1 of the "New main request" is additionally limited in that each Hall element takes up substantially a whole quadrant. It is, therefore,

narrower in scope than claim 1 of the *second auxiliary request*.

12. Further, and contrary to the appellant's view, the amendment in wording in feature (4) of claim 1, from *wherein said Hall elements of said pair are arranged [...]* to *wherein said square plates of said pair are arranged [...]* does not affect the scope of the claim. This amendment merely aligns the claim wording with the wording of claim 1 as granted, thereby eliminating an amendment made during the opposition proceedings which was not occasioned by a ground for opposition and, therefore, not in compliance with Rule 80 EPC. The Board is not persuaded by the appellant's argument that the word "comprises" in feature (2) implies that a Hall element has further components other than a square plate with two pairs of opposing contacts in the corners of the plate, and that for this reason a Hall element is an aliud compared with a square plate. Within the terminology of the patent and the content of Figure 2, a Hall element is coterminous with a square plate having a two pairs of opposing contacts in the corners of the square plate. Therefore, and contrary to the appellant's view, a square plate in the terminology of the patent is not an aliud.

13. The New main request, therefore, does not contravene the principle of prohibition of reformatio in peius.

Amendments - unsearched matter

14. The Board is not persuaded by the appellant's allegation that the *New auxiliary request* defines unsearched subject-matter. Apart from the fact that this is not a ground for revocation of the patent, the

wording *A Hall sensor comprising a pair of Hall elements*, in claim 1 as originally filed, clearly directed the Search Division to consider Hall sensors having one or more pairs of Hall elements. Even though the documents cited in the search report disclose only Hall sensors having two or more pairs, this cannot be taken as an indication that the Search Division excluded documents disclosing a Hall sensor with only a single pair.

Patentability

15. E3 discloses a Hall sensor array with two Hall elements (Figures 1 and 2). It is stated that they have the same geometry and are technologically, thermically and spatially closely coupled (claim 1). Hall elements are shown in Figures 1 and 2 as square plates, with four contacts arranged in pairs at the corners. The axes of the pairs are mutually orthogonal. The Hall elements form a pair which is configured for a two-phase measurement cycle, so that the contact pairs for injecting a current and for tapping the Hall voltage are pairwise alternated in successive measurement cycles. The two Hall elements are oriented at 0° and 45°, respectively. All this is apparent from Figures 1 and 2.

16. E3 further suggests that the orientation of Hall elements can be chosen between 0° and 180°. The angles can be chosen by taking into account the stress sensitivity given by the crystal lattice (column 3, lines 26 to 32).

17. So far, the parties and the Board agree on the disclosure of E3.

18. However, the Board does not agree with the opponent's view that the Hall element as claimed in claim 1 is disclosed in E3 by the angular range proposed in column 1, line 38. Taking this range into account, the expert would, at most, be instructed to place two Hall elements at angles of 45° and -45° degrees on a substrate, if this selection of angles limits negative effects on the operation of the Hall element due to mechanical stresses in the crystal. However, E3 does not instruct the skilled person to arrange the Hall elements to reduce thermal offset. Thus, simply specifying the angular range in E1 does not instruct the skilled person to arrange the Hall elements to occupy the entire area of diagonally opposite quadrants of a square, nor does it instruct him not to become a Hall element in the remaining two quadrants. These features ensure that the heat generated in one Hall element by the excitation current and conducted through the substrate to the other Hall element heats the other Hall element symmetrically to the common diagonal of the Hall elements (1-3 in H1, 2-4 in H2, see above). This arrangement, therefore, avoids a thermal offset generated by the Hall element H2 in the contact pairs 2-4 of the H1 element (see figure above). Similarly, a thermal offset in contact pairs 1-3 in H2 does not occur when the H1 element heats up. E3, therefore, does not disclose arranging two Hall element sensors according to features (4) to (6) of claim 1.

19. The Hall sensor as defined in claim 1 is, therefore, novel.

20. Features (4) to (6) result, as explained above, in a Hall sensor with two Hall elements, in which, in particular, any thermally-induced offset is reduced when operating in a two-phase spinning-current mode.

The technical problem solved by the claimed Hall sensor over E3 can, therefore, be defined as obtaining a Hall sensor with reduced thermally-induced offset in a two-phase spinning-current mode.

21. E3 itself does not suggest a solution for this problem.

22. E1 only discloses Hall sensors comprising two or more pairs of Hall elements. It does not, therefore, teach the skilled person a solution using only a single pair.

23. Nor would the skilled person arrive at the claimed Hall sensor by taking account of E2. E2 discloses the compensation of the offset by pairing two Hall elements, by arranging them equally rotated on the substrate so that the resistivity increase induced by a resistivity gradient, strain, or misalignment appears at the same geometrical location in each Hall element, so that each is subject to the same increase in resistivity, which can be compensated by orthogonal biasing. This approach is the same as that described in E3, first column, lines 36 to 45. The skilled person, taking into account E2, would, therefore, not be lead to arrange the Hall elements for use in a two-phase measurement cycle such that each takes substantially an entire quadrant of a square.

24. For the above reasons, the opponent has not shown that the Hall sensor of claim 1 would have been obvious to the skilled person.

25. The method of claim 3 involves an inventive step for the same reasons.

Conclusion

26. For the above reasons, the patent in the text of the *New main request* meets the requirements of the Convention.

27. The Board notes that none of the documents E1 to E3, considered in the opposition proceedings, is cited in the description, and that paragraph 9 of the patent specification needs to be adapted to the wording of the claims. The adaptation of the description is to be done by the opposition division.

Order

For these reasons it is decided that:

The decision under appeal is set aside.
The case is remitted to the opposition division with the order to maintain the patent with a description to be adapted, the figures as granted, and:

Claims:
Nos. 1 to 3 of the New main request received during oral proceedings of 11 October 2019.

The Registrar: The Chairman:

D. Meyfarth P. Scriven

Decision electronically authenticated