Flux Guides for Magnetic Field Sensors and Memories

Abstract: A magnetic sensor has a magneto resistive sensing element (210) having layers of magnetic material and one or more flux guides (120) for concentrating the field onto the sensing element, the flux guide comprising a part of one or more of the same layers used for the sensing element. By using the same layer or layers for the flux guide the guide layer can be formed in the same step as the corresponding layer of the sensing element. Such sensors can be integrated in MRAM chips. Flux guides can be used to rotate the field differently for each of 2 parallel sensing elements, to enable 2D field sensors. As there is now no need for orthogonal exchange bias directions for the two sensors, they can be integrated more easily. Flux guides can also be used to concentrate the field for writing MRAM cells, and hence reduce write current.
Published: with international search report

(88) Date of publication of the international search report:
13 October 2005

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

| IPC 7 | G01R33/09 | G11C11/15 |

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)

| IPC 7 | G01R | G11C |

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 practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC, COMPENDEX

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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</thead>
<tbody>
<tr>
<td>X</td>
<td>US 5 898 547 A (FONTANA, JR. ET AL) 27 April 1999 (1999-04-27) column 5, line 8 - column 6, line 25; figures 4,5 column 8, line 18 - column 9, line 39</td>
<td>1-4, 6, 7, 9-11, 28, 29</td>
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<td>X</td>
<td>US 6 165 329 A (RODMACQ ET AL) 26 December 2000 (2000-12-26) column 5, line 15 - line 39; figure 1 column 7, line 11 - line 19</td>
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<td>A</td>
<td>US 4 455 626 A (LUTES ET AL) 19 June 1984 (1984-06-19) column 2, line 4 - line 16; figures 1, 2</td>
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* 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 document 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

**Date of the actual completion of the international search**

24 March 2005

**Date of mailing of the international search report**

21 June 2005

**Name and mailing address of the ISA**

European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 940-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3018

**Authorized officer**

Häusser, T
Box 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 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 fee, this Authority did not invite payment of any additional fee.

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.:

4. [X] 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.:

   1-11, 28, 29 (when referring to claims 1-11)

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest.

[ ] No protest accompanied the payment of additional search fees.
This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-11, 28, 29 (when referring to claims 1-11)
   Magnetic sensor with flux guides that are not fully saturated.

2. claims: 12-21, 29 (when referring to claims 12-21)
   Magnetic sensor with two sensing elements.

3. claims: 22-27
   Current sensor.

4. claims: 30-36
   Magnetic memory and method of manufacture.
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