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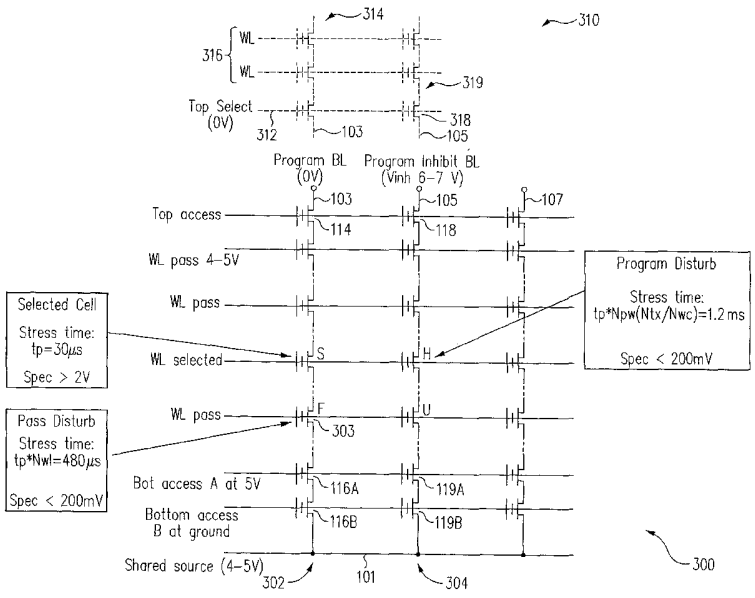
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[Continued on next page]

(54) Title: NAND MEMORY ARRAY INCORPORATING MULTIPLE SERIES SELECTION DEVICES AND METHOD FOR OPERATION OF SAME



(57) Abstract: An exemplary NAND string memory array (300) provides for capacitive boosting of a half-selected memory cell channel to reduce program disturb effects of the half selected cell. To reduce the effect of leakage current degradation of the boosted level, multiple series select devices at one or both ends of each NAND string reduce leakage through such select devices, for both unselected and selected NAND strings. An exemplary memory array may include series-connected NAND strings of memory cell transistors having a charge storage dielectric, and includes more than one plane of memory cells (400) formed above a substrate.

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European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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INTERNATIONAL SEARCH REPORT

Int nal Application No
PCT/US2004/040283

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G11C16/04

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 G11C H01L

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, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 151 249 A (SHIROTA ET AL) 21 November 2000 (2000-11-21) the whole document	1,4,5, 20,27, 30,34, 35,39
Y		2,28

Y	US 2001/055838 A1 (WALKER ANDREW J ET AL) 27 December 2001 (2001-12-27) paragraphs '0051!, '0061! - '0069!; figures 5,9	2,28

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in 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 document but published on or after the international filing date

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"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	Date of mailing of the international search report
9 May 2005	29. 07. 2005

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Trifonov, A

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Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

ırnational application No.
PCT/US2004/040283

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. ☒ 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.:

see annex

Remark on Protest

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

☐ 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: 1,2,20,28

   A three dimensional memory array comprising a plurality of series connected NAND strings

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2. claim: 3

   Modifiable conductance switch devices comprise thin film transistors

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3. claims: 6,7,13,32

   Modifiable conductance switch devices comprise transistors having depletion mode threshold voltage

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4. claims: 14,19,31

   Identical devices used for memory cell devices and series selection devices

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5. claims: 8-12,15-18,21-26,29,36-38

   Arrangements of NAND strings and their respective series selection devices to provide connection to global bitlines and bias nodes

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6. claim: 33

   A modifiable conductance switch device for storing more than one bit of data per memory cell

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Int nal Application No
PCT/US2004/040283

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6151249 A	21-11-2000	JP 3207592 B2	10-09-2001
		JP 6275800 A	30-09-1994
		KR 9616802 B1	21-12-1996
US 2001055838 A1	27-12-2001	US 2002088998 A1	11-07-2002
		WO 03017285 A1	27-02-2003
		AU 6295301 A	12-11-2001
		EP 1284017 A2	19-02-2003
		TW 507368 B	21-10-2002
		WO 0184553 A2	08-11-2001
		US 2002140051 A1	03-10-2002
		US 2003022420 A1	30-01-2003
		US 2003027378 A1	06-02-2003
		US 2003031067 A1	13-02-2003
		US 2003128581 A1	10-07-2003
		US 2004016991 A1	29-01-2004
		US 2004089917 A1	13-05-2004
		US 2004188798 A1	30-09-2004
		US 2004179398 A1	16-09-2004
		US 2003053332 A1	20-03-2003