

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
4 April 2002 (04.04.2002)

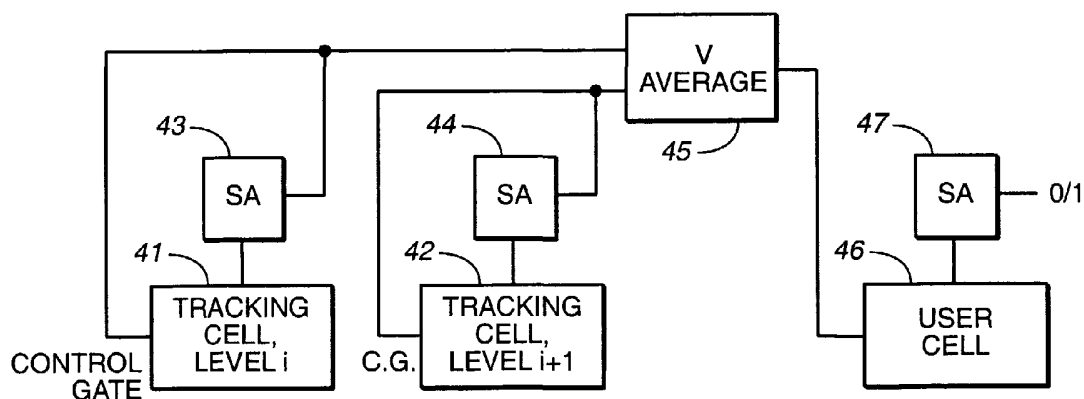
PCT

(10) International Publication Number
WO 02/027729 A3

- (51) International Patent Classification⁷: **G11C 11/56**, 27/00
- (21) International Application Number: PCT/US01/30123
- (22) International Filing Date:
25 September 2001 (25.09.2001)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
09/671,793 27 September 2000 (27.09.2000) US
- (71) Applicant: **SANDISK CORPORATION** [US/US]; 140 Caspian Way, Sunnyvale, CA 94089 (US).
- (72) Inventors: **KHALID, Shahzad, B.**; 32392 Derby Street, Union City, CA 94587 (US). **GUTERMAN, Daniel, C.**; 305 Jacaranda Drive, Fremont, CA 94539 (US). **GONG-WER, Geoffrey, S.**; 5328 Beechwood Lane, Los Angeles, CA 94024 (US). **SIMKO, Richard**; 27861 Black Mountain Road, Los Altos Hills, CA 94033 (US). **CONLEY, Kevin, M.**; 5983 Alvarado Court, San Jose, CA 95120 (US).
- (74) Agent: **CLEVELAND, Michael, G.**; Skjerven Morrill LLP, Three Embarcadero Center, 28th Floor, San Francisco, CA 94111 (US).
- (81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.
- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- Published:
— with international search report
- (88) Date of publication of the international search report:
12 December 2002

[Continued on next page]

(54) Title: WRITABLE TRACKING CELLS



(57) Abstract: The present invention presents several techniques for using writable tracking cells. Multiple tracking cells are provided for each write block of the memory. These cells are re-programmed each time the user cells of the associated write block are written, preferably at the same time, using the same fixed, global reference levels to set the tracking and user cell programmed thresholds. The threshold voltages of the tracking cells are read every time the user cells are read, and these thresholds are used to determine the stored logic levels of the user cells. In one set of embodiments, populations of one or more tracking cells are associated with different logic levels of a multi-state memory. These tracking cell populations may be provided for only a subset of the logic levels. The read points for translating the threshold voltages are derived for all of the logic levels based upon this subset. In one embodiment, two populations each consisting of multiple tracking cells are associated with two logic levels of the multi-bit cell. In an analog implementation, the user cells are read directly using the analog threshold values of the tracking cell populations without their first being translated to digital values. A set of alternate embodiments provide for using different voltages and/or timing for the writing of tracking cells to provide less uncertainty in the tracking cells' final written thresholds.



WO 02/027729 A3



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

International Application No

PCT/US 01/30123

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G11C11/56 G11C27/00

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 00 42615 A (AGATE SEMICONDUCTOR INC) 20 July 2000 (2000-07-20)	1,2,4, 8-11, 13-16, 18, 22-25, 27-31, 33,37, 38,43, 56,57, 60-62, 67,73, 74, 77-79, 84, 90-94, 102
Y		3,17,32, 44,68, 72,85,
	-/--	



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

"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

8 May 2002

Date of mailing of the international search report

20. 09. 2002

Name and mailing address of the ISA

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

Authorized officer

Colling, P

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 01/30123

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	<p>page 52, line 9 -page 57, line 6 page 61, line 24 -page 71, line 26 figures 13-27</p> <p>---</p>	89,101, 103
Y	<p>WO 99 08284 A (SANDISK CORP) 18 February 1999 (1999-02-18) cited in the application</p>	44,68, 85,103
A		1,2,4, 8-11, 13-16, 18, 22-25, 27-31, 33,37, 38,43, 56,57, 60-62, 67,73, 74, 77-79, 84, 90-94, 102
Y	<p>page 9, line 25 -page 31, line 31</p> <p>---</p> <p>US 5 541 886 A (HASBUN ROBERT) 30 July 1996 (1996-07-30)</p>	3,17,32, 72,89, 101
Y	<p>column 4, line 11 -column 13, line 44</p> <p>---</p> <p>US 5 270 979 A (GUTERMAN DANIEL C ET AL) 14 December 1993 (1993-12-14) cited in the application column 9, line 47 -column 12, line 19 claim 1</p>	44,68, 85,103
A	<p>---</p> <p>US 6 094 368 A (CHING WONG SAU) 25 July 2000 (2000-07-25) column 12, line 47 - line 61</p> <p>-----</p>	44,68, 85,103

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 01/30123

Box I Observations where certain claims were found unsearchable (Continuation of item 1 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 II Observations where unity of invention is lacking (Continuation of item 2 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.:
1-4, 8-11, 13-18, 22-25, 27-33, 37, 38, 43, 44, 56, 57, 60-62, 67, 68, 72-74, 77-79, 84, 85, 89-94, 101-103

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: 1-4,8-11,13-18,22-25,27-33,37,38,43,44,56,57,60-62,67,68,72-74,77-79,84,85,89-94,101-103

MULTIBIT MEMORY WITH CELLS STORING ERROR CORRECTION CODE

- 1.1. Claims: 44,68,85,103
ROTATION CIRCUIT FOR TRACKING CELLS

2. Claims: 5-7,19-21,34-36,42,54,55,69-71,86-88,98-100,105,106

WRITABLE TRACKING CELLS USING SAME REFERENCE VALUES FOR PROGRAM VERIFY AS MEMORY DATA CELLS

3. Claims: 12,26,58,59,75,76

LOOK-UP TABLE STORING REFERENCE VALUES FOR READOUT OF MULTIBIT MEMORY CELLS

4. Claims: 116-129

ANALOG VALUE TRACKING CELLS AND ASSOCIATED SENSE AMPLIFIERS

5. Claims: 39-41,63-66,80-83,95-97

AVERAGING CIRCUIT FOR TRACKING CELLS

6. Claims: 45-53,104,107-115

PROGRAMMING ALGORITHM FOR TRACKING CELLS

Please note that all inventions mentioned under item 1, although not necessarily linked by a common inventive concept, could be searched without effort justifying an additional fee.

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter: 1st Application No

PCT/US 01/30123

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 0042615	A	20-07-2000	US 6282145 B1 AU 2967000 A EP 1145248 A2 TW 459228 B WO 0042615 A2 US 2002036920 A1 US 2002039322 A1 US 2002041516 A1	28-08-2001 01-08-2000 17-10-2001 11-10-2001 20-07-2000 28-03-2002 04-04-2002 11-04-2002
WO 9908284	A	18-02-1999	US 6222762 B1 JP 2001504973 T WO 9908284 A2 US 6317363 B1 US 6317364 B1 US 6275419 B1	24-04-2001 10-04-2001 18-02-1999 13-11-2001 13-11-2001 14-08-2001
US 5541886	A	30-07-1996	NONE	
US 5270979	A	14-12-1993	US 5504760 A US 5396468 A US 5369615 A	02-04-1996 07-03-1995 29-11-1994
US 6094368	A	25-07-2000	NONE	