

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
21 March 2002 (21.03.2002)

PCT

(10) International Publication Number
WO 02/023550 A3

(51) International Patent Classification⁷: G06F 13/16, 13/40, G11C 5/00

(21) International Application Number: PCT/US01/29383

(22) International Filing Date:
18 September 2001 (18.09.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/665,196 18 September 2000 (18.09.2000) US

(71) Applicant (for all designated States except US): INTEL CORPORATION [US/US]; 2200 Mission College Boulevard, Santa, CA 95052 (US).

(72) Inventors; and

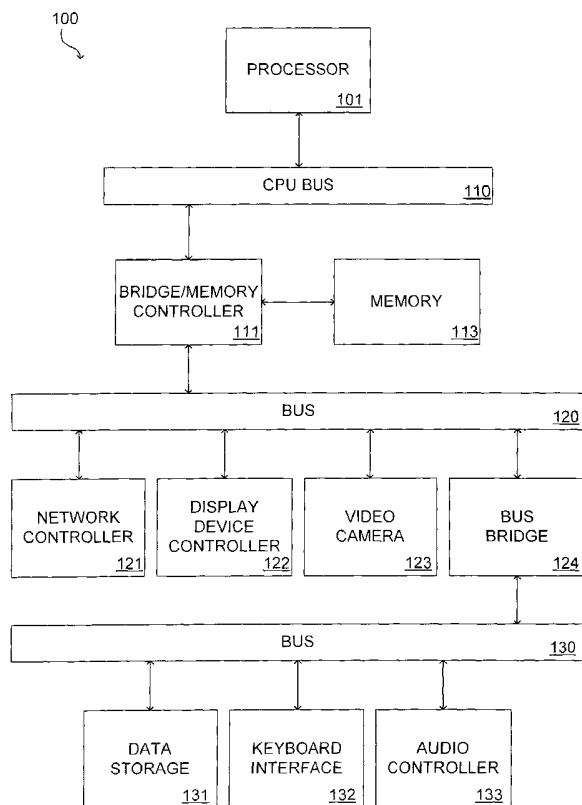
(75) Inventors/Applicants (for US only): HALBERT, John [US/US]; 15045 SW Emerald Court, Beaverton, OR 97007 (US). BONELLA, Randy [US/US]; 4122 SW Garden Home Road, Portland, OR 97219 (US). LAM, Chung [US/US]; 560 Dory Lane, Redwood Shores, CA 94065 (US). DODD, James [US/US]; 4561 Barnett Ranch Road, Shingle Springs, CA 95682 (US).

(74) Agent: MALLIE, Michael, J.; Blakely Sokoloff Taylor & Zafman, 7th Floor, 12400 Wilshire Boulevard, Los Angeles, CA 90025 (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,

[Continued on next page]

(54) Title: APPARATUS FOR IMPLEMENTING A BUFFERED DAISY-CHAIN CONNECTION BETWEEN A MEMORY CONTROLLER AND MEMORY MODULES



(57) Abstract: A plurality of memory modules interface through a daisy-chain providing a point-to-point connection for each memory module. The first and the last memory module in the daisy chain each connect to a separate memory controller port forming a ring circuit. A distinct set of signals connect the memory modules in each direction. A junction circuit in each memory module provides line isolation, a coupling to the adjoining memory modules in the daisy chain or in the case of the first and last memory module in the daisy chain, a memory module and a memory controller, and a data synchronization circuit. Each junction circuit provides as well as voltage conversion so that the memory devices on a memory module operate at a different voltage than the memory controller, and multiplexing/de-multiplexing so that a lesser number of lines interface with each junction circuit.

WO 02/023550 A3



SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU,
ZA, ZW.

Published:

— *with international search report*

(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).

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

10 July 2003

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 01/29383

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G06F13/16 G06F13/40 G11C5/00

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 G06F 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)

WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No. 1-7
X	US 6 028 781 A (VOGLEY ET AL) 22 February 2000 (2000-02-22) column 4, line 52 -column 5, line 63 figures 4-8	1,6
A	US 5 828 892 A (MIZUTA) 27 October 1998 (1998-10-27) column 1, line 47 -column 4, line 12	2,3,7,8
A	US 4 974 152 A (GUIFFANT ET AL) 27 November 1990 (1990-11-27) column 3, line 14 -column 4, line 53 figures 2,3	4,5,9,10
A	US 5 448 715 A (LELM ET AL) 5 September 1995 (1995-09-05) column 4, line 33 -column 6, line 29 figures 1,2	1,6

 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

21 March 2003

Date of mailing of the international search report

31/03/2003

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

McDonagh, F

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 01/29383

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 6028781	A	22-02-2000	EP 0849737 A2 JP 10301888 A	24-06-1998 13-11-1998
US 5828892	A	27-10-1998	JP 9231339 A	05-09-1997
US 4974152	A	27-11-1990	FR 2598836 A1 AT 68612 T DE 3773741 D1 EP 0246168 A1	20-11-1987 15-11-1991 21-11-1991 19-11-1987
US 5448715	A	05-09-1995	NONE	