US007414312B2

(12) **United States Patent**
Nguyen et al.

(10) **Patent No.: US 7,414,312 B2**
(45) **Date of Patent: Aug. 19, 2008**

(54) **MEMORY-MODULE BOARD LAYOUT FOR USE WITH MEMORY CHIPS OF DIFFERENT DATA WIDTHS**

(75) Inventors: **Henry H. D. Nguyen**, Fountain Valley, CA (US); **Mark Burlington**, Aliso Viejo, CA (US)

(73) Assignee: **Kingston Technology Corp.**, Fountain Valley, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 569 days.

(21) Appl. No.: **10/908,718**

(22) Filed: **May 24, 2005**

(65) **Prior Publication Data**

US 2006/0267172 A1 Nov. 30, 2006

(51) **Int. Cl.**
H01L 23/34 (2006.01)
H05K 7/00 (2006.01)
G11C 5/06 (2006.01)

(52) **U.S. Cl.** **257/724**; 257/786; 257/E23.141; 361/760; 361/784; 361/803; 365/63

(58) **Field of Classification Search** ..... None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,884,237	A	11/1989	Mueller et al.	365/63
5,754,408	A *	5/1998	Derouiche	361/773
6,038,132	A *	3/2000	Tokunaga et al.	361/760
6,542,393	B1	4/2003	Chu et al.	365/51
6,614,664	B2	9/2003	Lee	361/784
6,751,113	B2	6/2004	Bhakta et al.	365/63
6,839,241	B2	1/2005	Benisek et al.	361/760
6,891,729	B2 *	5/2005	Ko et al.	361/736
7,224,595	B2 *	5/2007	Dreps et al.	365/63
7,337,522	B2 *	3/2008	Engle et al.	29/564.1
7,356,737	B2 *	4/2008	Cowell et al.	714/42
2002/0133665	A1	9/2002	Mailloux et al.	711/105
2003/0067063	A1	4/2003	Muff et al.	257/678
2004/0186956	A1	9/2004	Perego et al	711/115
2004/0221106	A1	11/2004	Perego et al.	711/115
2004/0256638	A1	12/2004	Perego et al.	257/200
2005/0044302	A1	2/2005	Pauley et al.	711/1

FOREIGN PATENT DOCUMENTS

JP 07022727 A * 1/1995

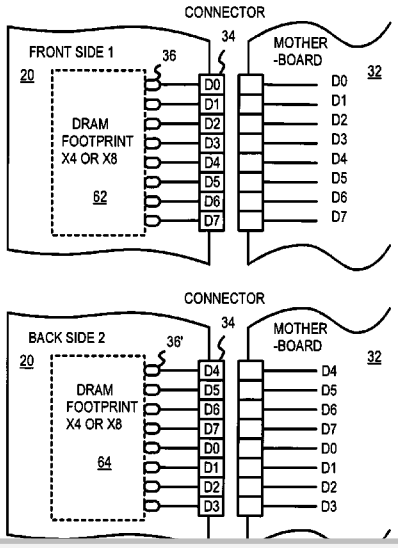
* cited by examiner

Primary Examiner—Alonzo Chambliss
(74) *Attorney, Agent, or Firm*—gPatent LLC; Stuart J. Auvinen

(57) **ABSTRACT**

A memory module substrate printed-circuit board (PCB) has multi-type footprints and an edge connector for mating with a memory module socket on a motherboard. Two or more kinds of dynamic-random-access memory (DRAM) chips with different data I/O widths can be soldered to solder pads around the multi-type footprints. When ×4 DRAM chips with 4 data I/O pins are soldered over the multi-type footprints, the memory module has a rank-select signal that drives chip-select inputs to all DRAM chips. When ×8 DRAM chips with 8 data I/O pins are soldered over the multi-type footprints, the memory module has two rank-select signals. One rank-select drives chip-select inputs to front-side DRAM chips while the second rank-select drives chip-select inputs to back-side DRAM chips. Wiring traces on the PCB cross-over data nibbles between the solder pads and the connector to allow two ×4 chips to drive a byte driven by only one ×8 chip.

20 Claims, 7 Drawing Sheets



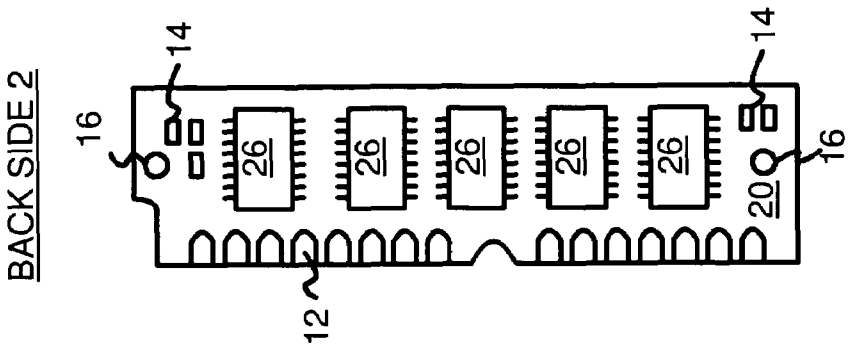


FIG. 1B PRIOR ART

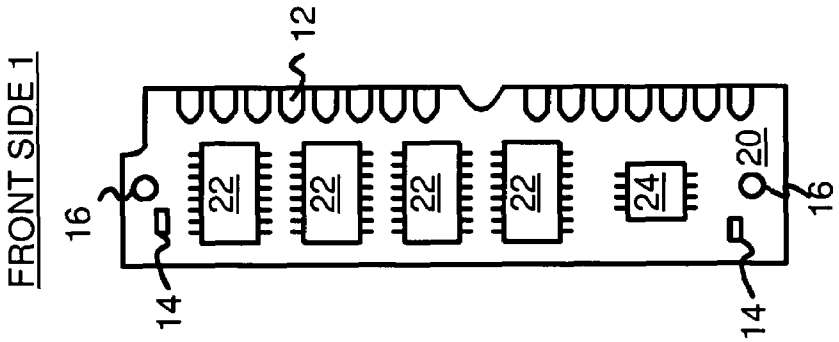
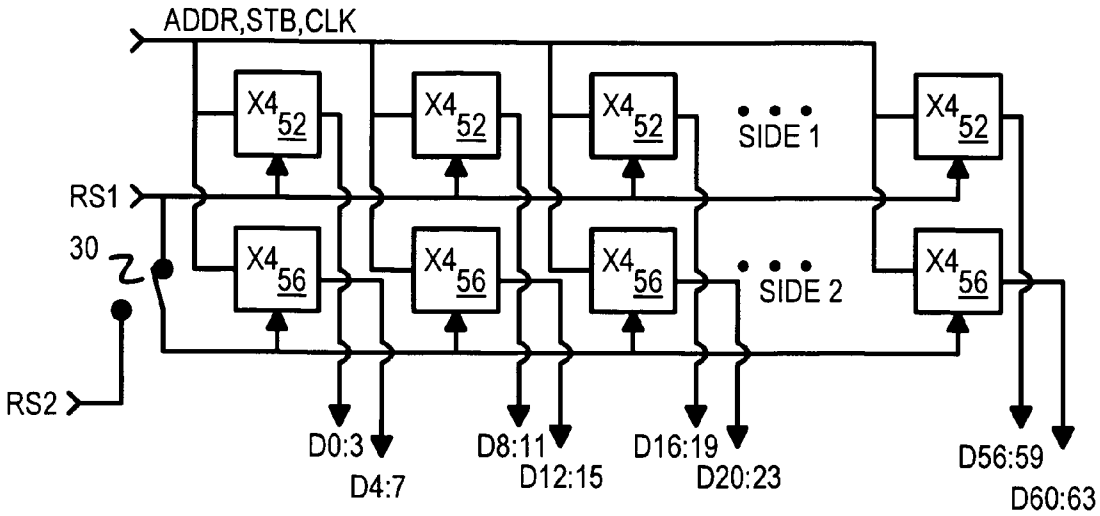
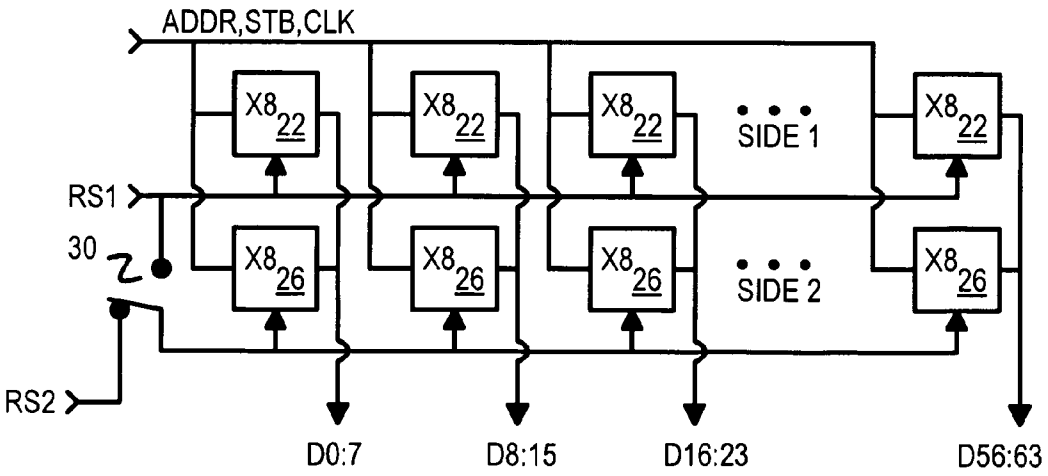


FIG. 1A PRIOR ART



16 CHIPS, 1 RANK FIG. 2A



16 CHIPS, 2 RANKS FIG. 2B

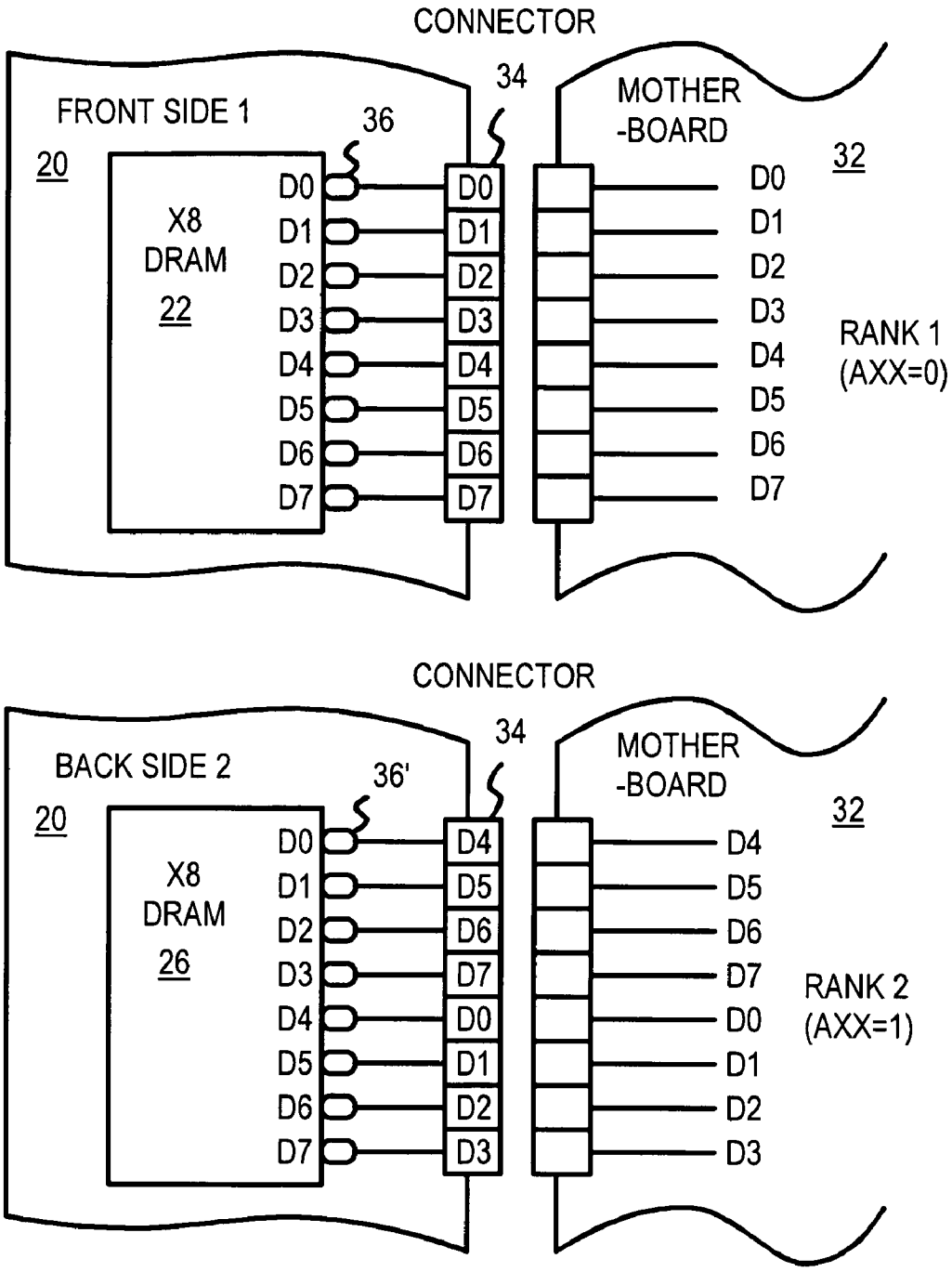


FIG. 3

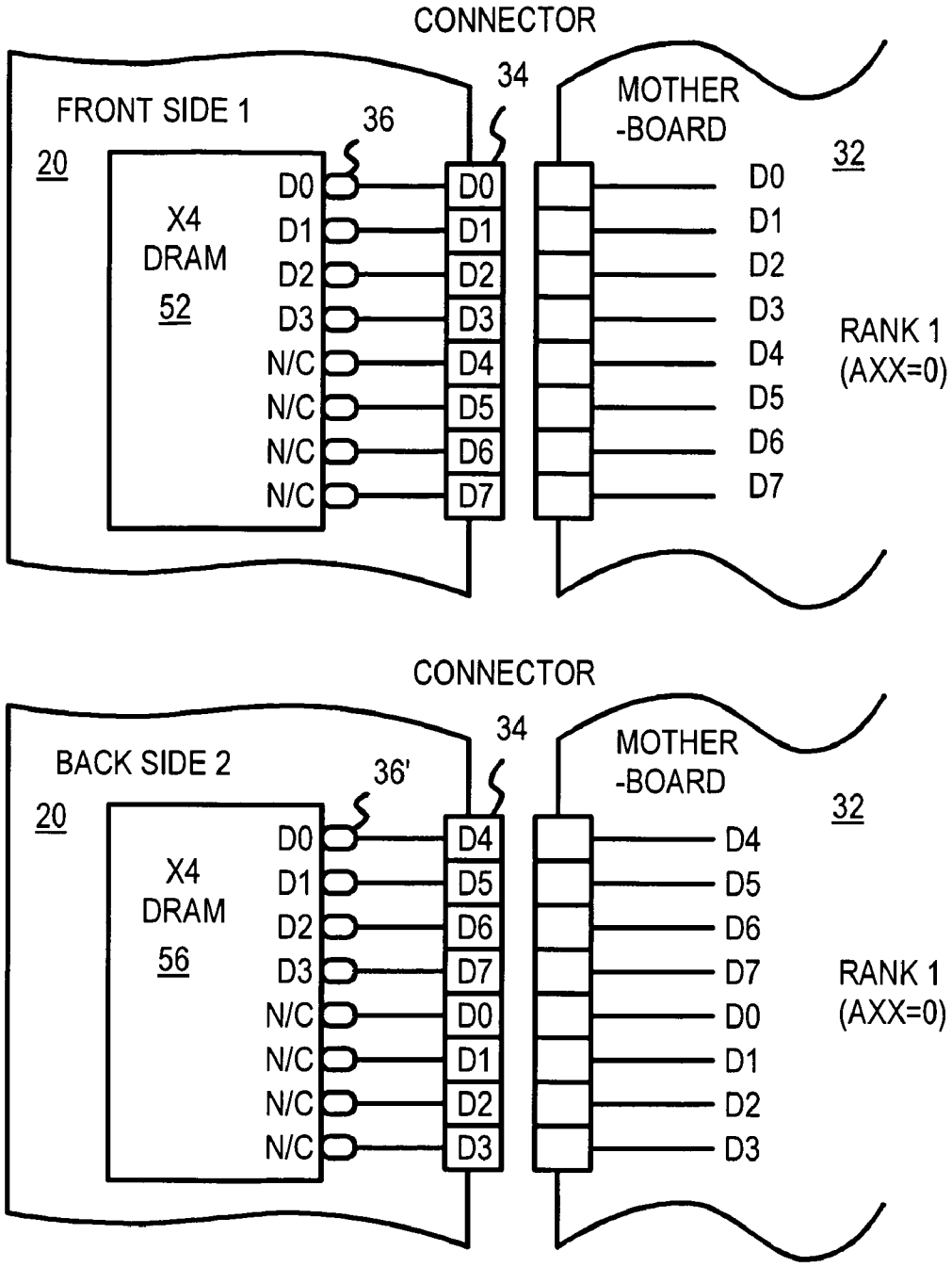


FIG. 4

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS
Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS
Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS
Sync your system to PACER to automate legal marketing.