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Franz et al.

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(54) **METHOD AND SYSTEM FOR SUPPORTING MULTIPLE CACHE CONFIGURATIONS**

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(73) Assignee: **International Business Machines Corporation**, Armonk, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 397 days.

(21) Appl. No.: **09/731,869**

(22) Filed: **Dec. 7, 2000**

(65) **Prior Publication Data**

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(51) **Int. Cl.**[7] **G06F 12/08**
(52) **U.S. Cl.** **365/230.05**; 711/104; 711/1
(58) **Field of Search** 365/230.05, 189.01, 365/189.04; 711/104, 1

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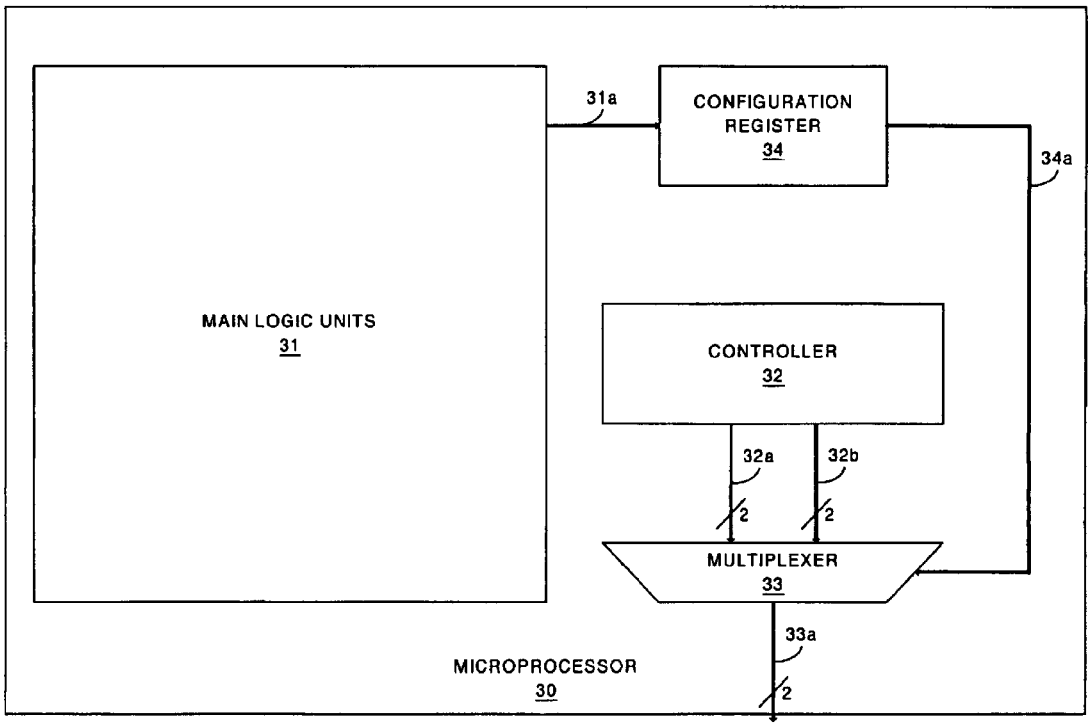
* cited by examiner

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(74) *Attorney, Agent, or Firm*—Cardinal Law Group; Casimer K. Salys

(57) **ABSTRACT**

A processor card for supporting multiple cache configurations, and a microprocessor for selecting one of the multiple cache configurations is disclosed. The processor card has a first static random access memory mounted on a front side thereof and a second static random access memory mounted on a rear side thereof. The address pins of the memories are aligned. Each pair of aligned address pins are electrically coupled to thereby concurrently receive an address bit signal from the microprocessor. During an initial boot of the microprocessor, the microprocessor includes a multiplexor for providing the address bit signals to the address pins in response to a control signal indicative of a selected cache configuration.

23 Claims, 4 Drawing Sheets



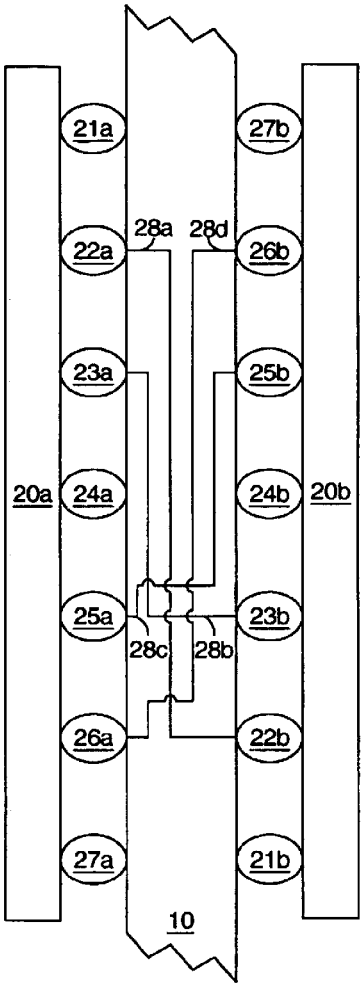


FIG. 1
(PRIOR ART)

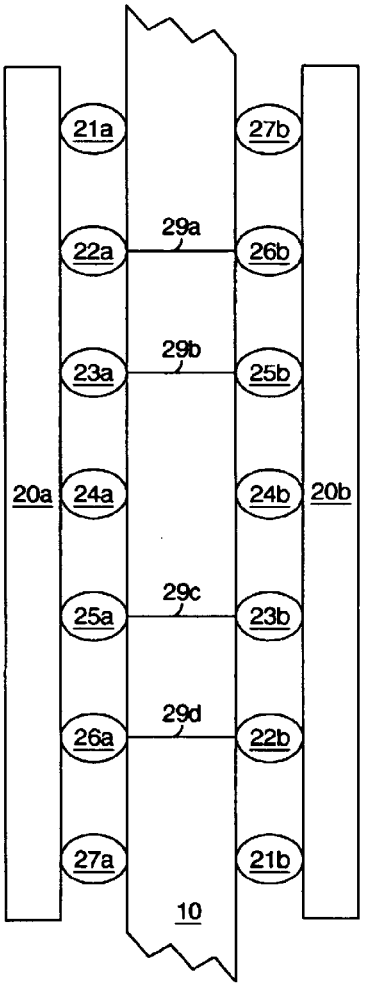


FIG. 2

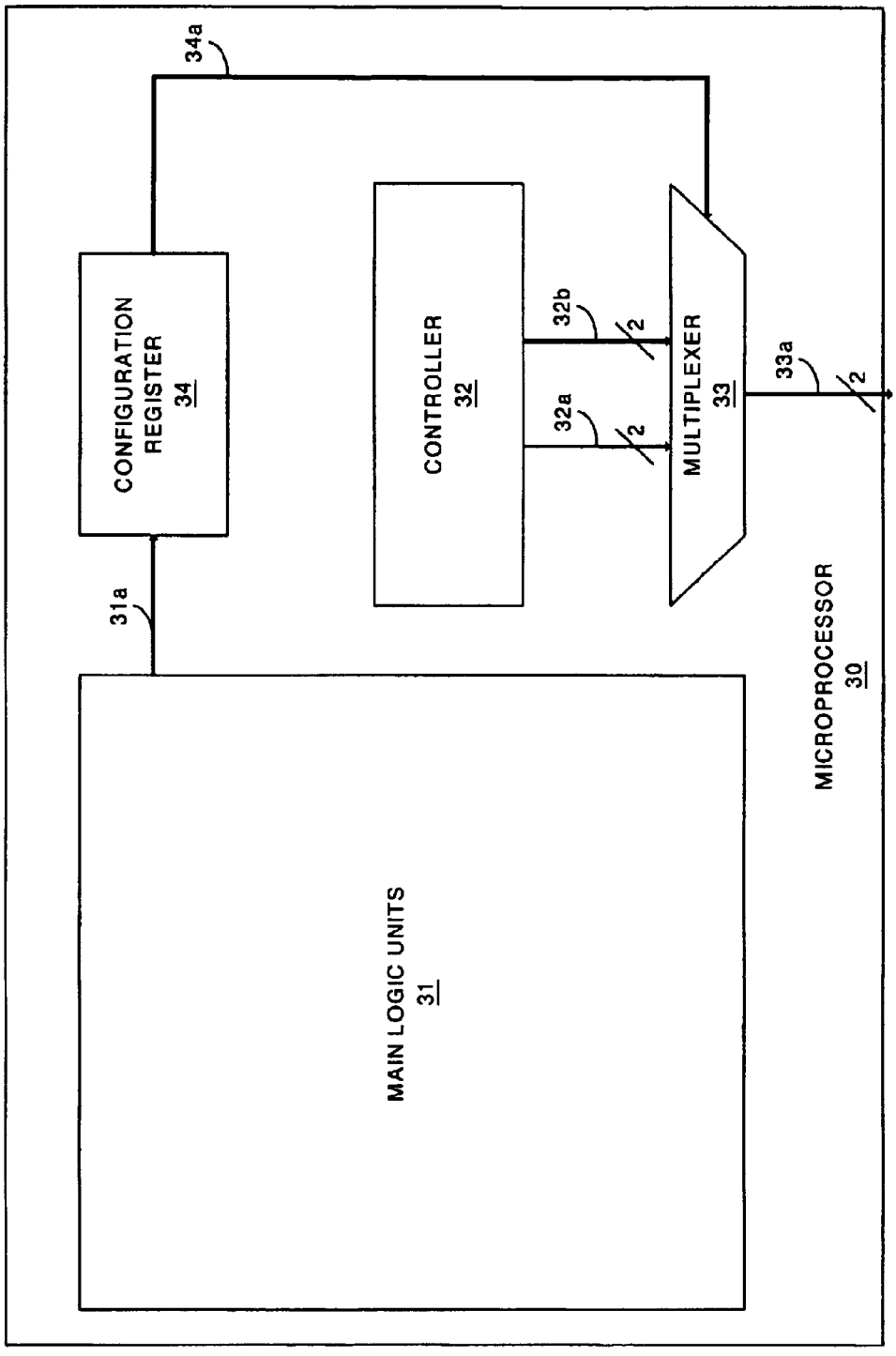

34a
CONFIGURATION REGISTER 34
CONTROLLER 32
32b
2
32a
2
MULTIPLEXER 33
33a
2
31a
MAIN LOGIC UNITS 31
MICROPROCESSOR 30

FIG. 3A

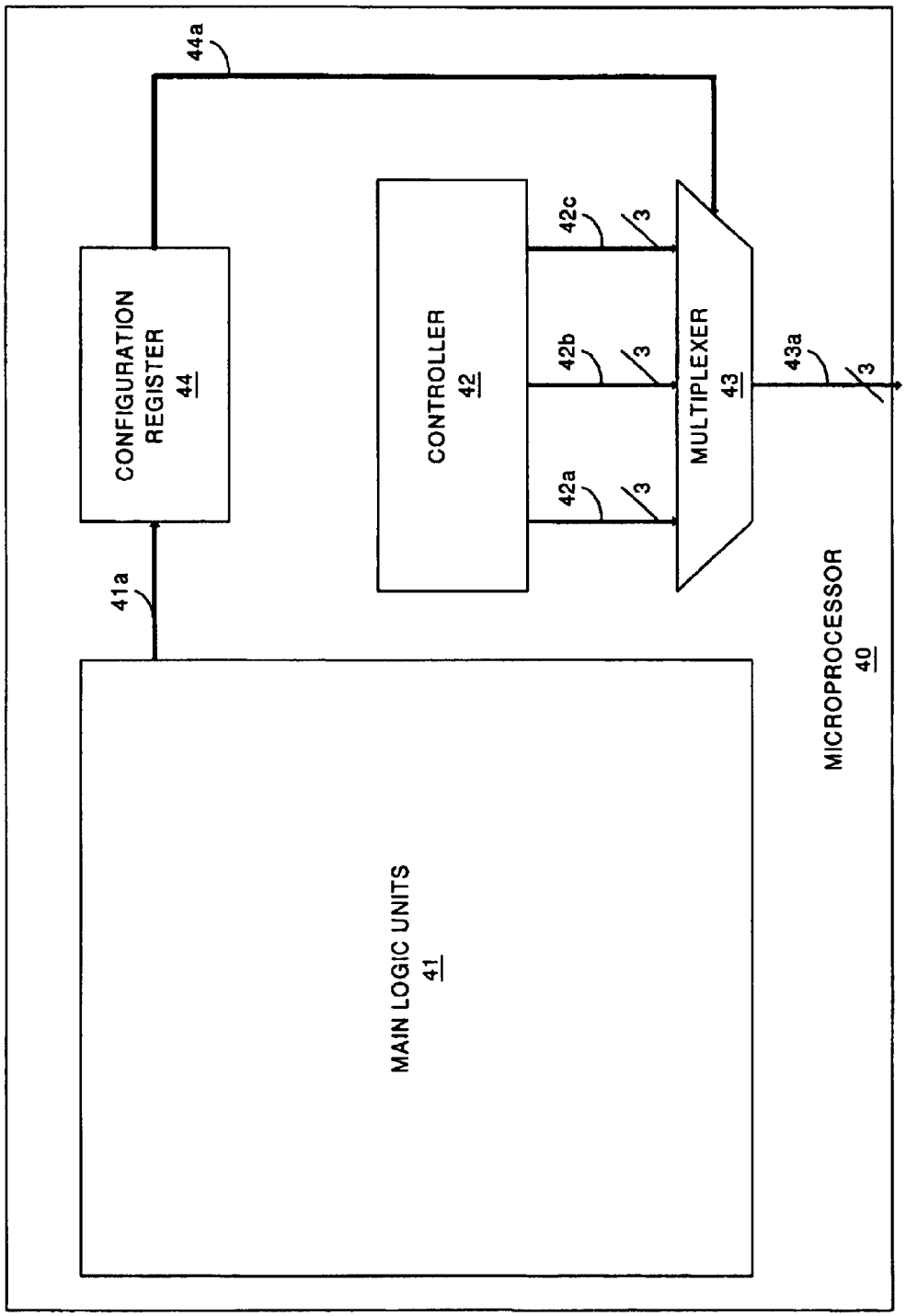

44a
CONFIGURATION REGISTER 44
CONTROLLER 42
42c
3
42b
3
42a
3
MULTIPLEXER 43
43a
3
41a
MAIN LOGIC UNITS 41
MICROPROCESSOR 40

FIG. 3B

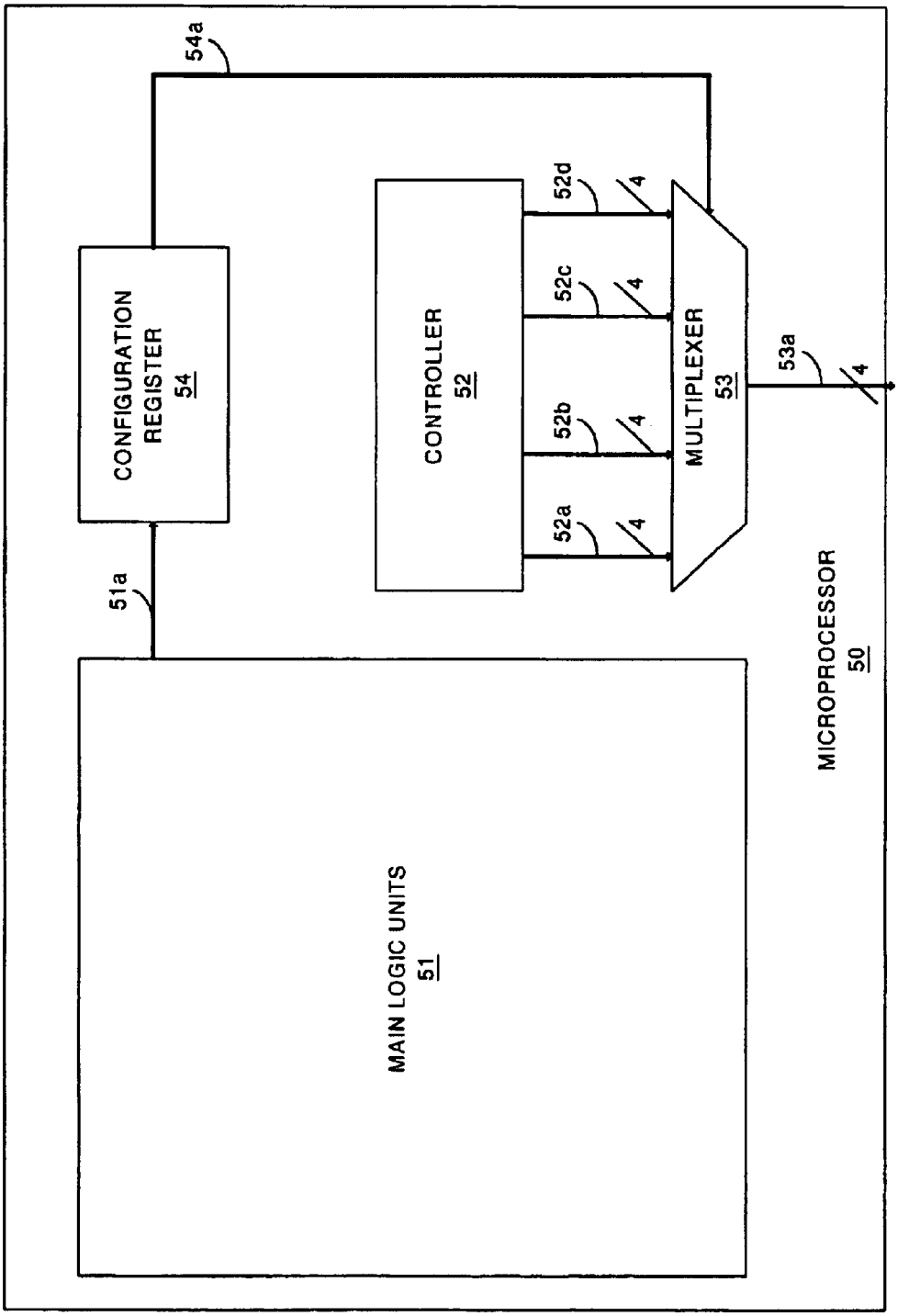

54a
CONFIGURATION REGISTER 54
51a
CONTROLLER 52
52d
52c
52b
52a
4
MULTIPLEXER 53
53a
4
MAIN LOGIC UNITS 51
MICROPROCESSOR 50

FIG. 3C

METHOD AND SYSTEM FOR SUPPORTING MULTIPLE CACHE CONFIGURATIONS

BACKGROUND OF THE INVENTION

Referring to FIG. **1**, an electrical coupling network between a static random access memory **20***a* (hereinafter "SRAM **20***a*") and a static random access memory **20***b* (hereinafter "SRAM **20***b*") is shown. SRAM **20***a* and SRAM **20***b* are identical memory devices. Specifically, both SRAM **20***a* and SRAM **20***b* have an identical pin arrangement including seven (7) rows and seventeen (17) columns of pins. The first column of pins are shown in FIG. **1**. In the first column of pins, SRAM **20***a* includes two (2) output power supply pins **21***a* and **27***a*, and SRAM **20***b* includes two (2) output power supply pins **21***b* and **27***b*. Also in the first column of pins, SRAM **20***a* includes four (4) synchronous address input pins **22***a*, **23***a*, **25***a*, and **26***a*, and SRAM **20***b* includes four (4) synchronous address input pins **22***b*, **23***b*, **25***b*, and **26***b*. Pin **24***a* of SRAM **20***a* and pin **24***b* of SRAM **20***b* are not utilized.

In support of four (4) cache configurations, SRAM **20***a* is mounted to a front side of a processor card **10**, and SRAM **20***b* is mounted to a rear side of processor card **10**. SRAM **20***a* and SRAM **20***b* are positioned with an alignment of pin **21***a* and pin **27***b*, an alignment of pin **22***a* and pin **26***b*, an alignment of pin **23***a* and pin **25***b*, an alignment of pin **24***a* and pin **24***b*, an alignment of pin **25***a* and pin **23***b*, an alignment of pin **26***a* and pin **22***b*, and an alignment of pin **27***a* and pin **21***b*.

Pin **22***a* and pin **22***b* are functionally equivalent and electrically coupled via a conductor **28***a* within processor card **10** to concurrently receive a first address bit signal from a microprocessor. Pin **23***a* and pin **23***b* are functionally equivalent and electrically coupled via a conductor **28***b* within processor card **10** to concurrently receive a second address bit signal from the microprocessor. Pin **25***a* and pin **25***b* are functionally equivalent and electrically coupled via a conductor **28***c* within processor card **10** to concurrently receive a third address bit signal from the microprocessor. Pin **26***a* and pin **26***b* are functionally equivalent and electrically coupled via a conductor **28***d* within processor card **10** to concurrently receive a fourth address bit signal from the microprocessor. The four (4) address bits signal are selectively provided by the microprocessor as a function of a selected cache configuration.

A drawback associated with the aforementioned electrical couplings as shown is the length of conductors **28***a*–**28***d* tends to establish a maximum frequency at which the microprocessor can effectively and efficiently control SRAM **20***a* and SRAM **20***b*, and the established maximum frequency can be significantly lower than a desired operating frequency of the microprocessor. The computer industry is therefore continually striving to improve upon the electrical coupling between the synchronous address input pins of SRAM **20***a* and SRAM **20***b* whereby a maximum frequency at which a microprocessor can effectively and efficiently control SRAM **20***a* and SRAM **20***b* matches a desired operating frequency of the microprocessor. The computer industry is also continually striving to improve upon the electrical communication of a selected cache configuration from a microprocessor to the synchronous address input pins of SRAM **20***a* and SRAM **20***b*.

FIELD OF THE INVENTION

The present invention generally relates to computer hardware mounted upon a processor card, and in particular to an electrical coupling between memory components for supporting multiple cache configurations and an electrical communication from a microprocessor to the memory components for selecting one of the supported multiple cache configurations.

SUMMARY OF THE INVENTION

One form of the present invention is a processor card having a first memory device and a second memory device mounted thereon. The first memory device includes a first address pin and a second address pin. The second memory device includes a third address pin and a fourth address pin. The first address pin of the first memory device and the third address pin of the second memory device are functionally equivalent address pins. The second address pin of the first memory device and the fourth address pin are functionally equivalent address pins. The first address pin of the first memory device and the fourth address pin of the second memory device are electrically coupled to thereby concurrently receive a first address bit signal. The second address pin of the first memory device and the third address pin of the second memory device are electrically coupled to thereby concurrently receive a second address bit signal.

Another form of the present invention is a system including a first memory device, a second memory device, and a microprocessor. The first memory device includes a first address pin and a second address pin. The second memory device includes a third address pin and a fourth address pin. The first address pin of the first memory device and the third address pin of the second memory device are functionally equivalent address pins. The second address pin of the first memory device and the fourth address pin are functionally equivalent address pins. The microprocessor is operable to concurrently provide a first address bit signal to first address pin of the first memory device and the fourth address pin of the second memory device. The microprocessor is further operable to concurrently provide a first address bit signal to second address pin of the first memory device and the third address pin of the second memory device.

The foregoing and other features and advantages of the invention will become further apparent from the following detailed description of the presently preferred embodiments, read in conjunction with the accompanying drawings. The detailed description and drawings are merely illustrative of the invention rather than limiting, the scope of the invention being defined by the appended claims and equivalents thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a fragmented side view of a processor card having a pair of static random accesses memories mounted thereon with an electrical coupling of synchronous address pins as known in the art;

FIG. **2** is view of the FIG. **1** processor card and FIG. **1** static random accesses memories with an electrical coupling of synchronous address pins in accordance with the present invention;

FIG. **3**A is a general block diagram of a first embodiment of a microprocessor in accordance with the present invention;

FIG. **3**B is a general block diagram of a second embodiment of a microprocessor in accordance with the present invention; and

FIG. **3**C is a general block diagram of one embodiment of a microprocessor in accordance with the present invention.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

Referring to FIG. **2**, SRAM **20***a* and SRAM **20***b* are mounted upon processor card **10** as previously described in connection with FIG. **1**. In accordance with the present invention, pin **22***a* and pin **26***b* are electrically coupled via a conductor **29***a* within processor card **10** to concurrently receive a first address bit signal. Pin **23***a* and pin **25***b* are electrically coupled via a conductor **29***a* within processor card **10** to concurrently receive a second address bit signal. Pin **25***a* and pin **23***b* are electrically coupled via a conductor **29***c* within processor card **10** to concurrently receive a third address bit signal. Pin **26***a* and pin **22***b* are electrically coupled via a conductor **29***d* within processor card **10** to concurrently receive a fourth address bit signal. The length of the conductors **29***a*–**29***d* facilitate an effective and efficient operation of SRAM **20***a* and SRAM **20***b* over a wide range of operating frequencies of a microprocessor.

Referring to FIG. **3**A, a microprocessor **30** in accordance with the present invention for selecting between two (2) of the four (4) cache configurations supported by SRAM **20***a* and SRAM **20***b* is shown. Microprocessor **30** includes main logic units **31** for interpreting and executing operating and application programs as would occur to one skilled in the art. Microprocessor **30** further includes a controller **32** and a multiplexer **33**. Address bus **32***a* and address bus **32***b* provide electrical communication between controller **32** and multiplexer **33**. Address bus **32***a* and address bus **32***b* each have two (2) address lines. Multiplexer **33** has an address bus **33***a* with a first address line electrically coupled to pin **22***a* (FIG. **2**) and pin **26***b* (FIG. **2**), and a second address line electrically coupled to pin **26***a* (FIG. **2**) and pin **22***b* (FIG. **2**). The following Table 1 exemplary illustrates an address bit logic utilized by main logic units **31** for electrically communicating a selected cache configuration between an 8 Mbyte cache and a 16 Mbyte cache to SRAM **20***a* and SRAM **20***b*.

TABLE 1

	hc,3 ADDRESS BUS	CACHE SIZE	FIRST SECOND ADDRESS ADDRESS LINE (MSB) LINE (LSB)
32a	8 Mbyte	net2	net2
32b	16 Mbyte	net1	net2

Still referring to FIG. **3**A, microprocessor **30** further comprises a configuration register **34**. Configuration register **34** provides a control signal to multiplexor **33** via a control bus **34***a* in response to a selection signal from main logic units **31** via a data bus **31***a*. The selection signal is indicative of a selected cache configuration by main logic units **31** during an initial boot of microprocessor **30**. The control signal is indicative of the address bus that corresponds to the selected cache configuration. Consequently, multiplexor **33** provides the appropriate address signals via address bus **33***a* to SRAM **20***a* and SRAM **20***b* in response to the selection signal. For example, when the selection signal indicates the 16 Mbyte cache has been selected during an initial boot of microprocessor **30**, pin **22***a* and pin **26***b* concurrently receive address signal net**1**, and pin **26***a* and pin **22***b* concurrently receive address signal net**2** as indicated by Table 1.

Referring to FIG. **3**B, a microprocessor **40** in accordance with the present invention for selecting between three (3) of the four (4) cache configurations supported by SRAM **20***a* and SRAM **20***b* is shown. Microprocessor **40** includes main logic units **41** for interpreting and executing operating and application programs as would occur to one skilled in the art. Microprocessor **40** further includes a controller **42** and a multiplexer **43**. Address bus **42***a*, address bus **42***b*, and address bus **42***c* provide electrical communication between controller **42** and multiplexer **43**. Address bus **42***a* address bus **42***b*, and address bus **42***c* each have three (3) address lines. Multiplexer **43** has an address bus **43***a* with a first address line electrically coupled to pin **22***a* (FIG. **2**) and pin **26***b* (FIG. **2**), a second address line electrically coupled to pin **26***a* (FIG. **2**) and pin **22***b* (FIG. **2**), and a third address line electrically coupled to pin **23***a* (FIG. **2**) and pin **25***b* (FIG. **2**). The following Table 2 exemplary illustrates the address bit logic utilized by main logic units **41** for electrically communicating a selected cache configuration between a 4 Mbyte cache, an 8 Mbyte cache and a 16 Mbyte cache to SRAM **20***a* and SRAM **20***b*.

TABLE 2

ADDRESS BUS	CACHE SIZE	FIRST ADDRESS LINE (MSB)	SECOND ADDRESS LINE	THIRD ADDRESS LINE (LSB)
32a	4 Mbyte	net3	net3	net3
32b	8 Mbyte	net2	net2	net3
32c	16 Mbyte	net1	net2	net3

Still referring to FIG. **3**B, microprocessor **40** further comprises a configuration register **44**. Configuration register **44** provides a control signal to multiplexor **43** via a control bus **44***a* in response to a selection signal from main logic units **41** via a data bus **41***a*. The selection signal is indicative of a selected cache configuration by main logic units **41** during an initial boot of microprocessor **40**. The control signal is indicative of the address bus that corresponds to the selected cache configuration. Consequently, multiplexor **43** provides the appropriate address signals via address bus **43***a* to SRAM **20***a* and SRAM **20***b* in response to the selection signal. For example, when the selection signal indicates the 8 Mbyte cache has been selected, pin **22***a* and pin **26***b* concurrently receive address signal net**2**, pin **26***a* and pin **22***b* concurrently receive address signal net**2**, and pin **23***a* and pin **25***b* concurrently receive address signal net**3** as indicated by Table 2.

Referring to FIG. **3**C, a microprocessor **50** in accordance with the present invention for selecting between all four (4) cache configurations supported by SRAM **20***a* and SRAM **20***b* is shown. Microprocessor **50** includes main logic units **51** for interpreting and executing operating and application programs as would occur to one skilled in the art. Microprocessor **50** further includes a controller **52** and a multiplexer **53**. Address bus **52***a*, address bus **52***b*, address bus **52***c*, and address bus **52***d* provide electrical communication between controller **52** and multiplexer **53**. Address bus **52***a* address bus **52***b*, address bus **52***c*, and address bus **52***d* each have four (4) address lines. Multiplexer **53** has an address bus **53***a* with a first address line electrically coupled to pin **22***a* (FIG. **2**) and pin **26***b* (FIG. **2**), a second address line electrically coupled to pin **26***a* (FIG. **2**) and pin **22***b* (FIG. **2**), a third address line electrically coupled to pin **23***a* (FIG. **2**) and pin **25***b* (FIG. **2**), and a fourth address line electrically coupled to pin **23***b* (FIG. **2**) and pin **25***a* (FIG. **2**). The following Table 3 exemplary illustrates the address bit logic utilized by main logic units **51** for electrically communicating a selected cache configuration between a 2 Mbyte cache, a 4 Mbyte cache, an 8 Mbyte cache and a 16 Mbyte cache to SRAM **20***a* and SRAM **20***b*.

TABLE 3

AD-DRESS BUS	CACHE SIZE	FIRST ADDRESS LINE (MSB)	SECOND AD-DRESS LINE	THIRD AD-DRESS LINE	FOURTH ADDRESS LINE (LSB)
32a	2 Mbyte	net4	net4	net4	net4
32b	4 Mbyte	net3	net3	net3	net4
32c	8 Mbyte	net2	net2	net3	net4
32d	16 Mbyte	net1	net2	net3	net4

Still referring to FIG. **3**C, microprocessor **50** further comprises a configuration register **54**. Configuration register **54** provides a control signal to multiplexor **53** via a control bus **54***a* in response to a selection signal from main logic units **51** via a data bus **51***a*. The selection signal is indicative of a selected cache configuration by main logic units **51** during an initial boot of microprocessor **50**. The control signal is indicative of the address bus that corresponds to the selected cache configuration. Consequently, multiplexor **53** provides the appropriate address signals via address bus **53***a* to SRAM **20***a* and SRAM **20***b* in response to the selection signal. For example, when the selection signal indicates the 8 Mbyte cache has been selected, pin **22***a* and pin **26***b* concurrently receive address signal net**2**, pin **26***a* and pin **22***b* concurrently receive address signal net**2**, pin **23***a* and pin **25***b* concurrently receive address signal net**3**, and pin **23***b* and pin **25***a* concurrently receive address signal net**4** as indicated by Table 3.

From the previous description of SRAM **20***a* and SRAM **20***b* herein in connection with FIG. **2**, one skilled in the art will know how to make and use electrical couplings between additional synchronous address pins of SRAM **20***a* and SRAM **20***b* in accordance with the present invention. From the previous description of microprocessors **30**, **40**, and **50** in connection with FIGS. **3**A–**3**C, respectively, one skilled in the art will know how to make and use microprocessors in accordance with the present invention for selecting a cache configuration between five or more supported cache configurations.

While the embodiments of the present invention disclosed herein are presently considered to be preferred, various changes and modifications can be made without departing from the spirit and scope of the invention. The scope of the invention is indicated in the appended claims, and all changes that come within the meaning and range of equivalents are intended to be embraced therein. For examples, the pin configuration and size of SRAM **20***a* and SRAM **20***b* can vary, and/or SRAM **20***a* and SRAM **20***b* may include asynchronous address pins. Additionally, SRAM **20***a* and SRAM **20***b* may be misaligned along the respective sides of processor card **10**, and/or mounted on the same side of processor card **10**. Also, other memory devices may be utilized in lieu of SRAM **20***a* and SRAM **20***b*, e.g. dynamic static random access memories.

We claim:

1. A device, comprising:

a processor card;

a first memory device mounted upon said processor card, said first memory device including a first address pin and a second address pin; and

a second memory device mounted upon said processor card, said second memory device including a third address pin and a fourth address pin, said first address pin and said third address pin being functionally equivalent address pins, said second address pin and said fourth address pin being functionally equivalent address pins,

wherein said first address pin and said fourth address pin are electrically coupled to thereby concurrently receive a first address bit signal, and

wherein said second address pin and said third address pin are electrically coupled to thereby concurrently receive a second address bit signal.

2. The device of claim **1**, wherein

said first memory device is mounted to a front side of said processor card; and

said second memory device is mounted to a rear side of said processor card.

3. The device of claim **2**, wherein

said first address pin and said fourth address pin are aligned; and

said second address pin and said third address pin are aligned.

4. The device of claim **1**, wherein

said first memory device is a static random access memory; and

said second memory device is a static random access memory.

5. The device of claim **1**, wherein

said first memory device further includes a fifth address pin; and

said second memory device further includes a sixth address pin, said fifth address pin and said sixth address pin being electrically coupled to thereby concurrently receive a third address bit signal.

6. The device of claim **5**, wherein

said fifth address pin and said sixth address pin are functionally dissimilar address pins.

7. The device of claim **5**, wherein

said first memory device further includes a seventh address pin; and

said second memory device further includes an eighth address pin, said seventh address pin and said eighth address pins being electrically coupled to thereby concurrently receive a fourth address bit signal.

8. The device of claim **7**, wherein

said fifth address pin and said eighth address pin are functionally equivalent address pins; and

said sixth address pin and said seventh address pin are functionally equivalent address pins.

9. A system, comprising:

a first memory device including a first address pin and a second address pin;

a second memory device including a third address pin and a fourth address pin, said first address pin and said third address pin being functionally equivalent address pins, said second address pin and said fourth address pin being functionally equivalent address pins; and

a microprocessor operable to concurrently provide a first address bit signal to said first address pin and said fourth address pin, said microprocessor further operable to concurrently provide a second address bit signal to said second address pin and said third address pin.

10. The system of claim **9**, further comprising:

a processor card having said first memory device and said second memory device mounted thereon.

11. The system of claim **10**, wherein

said first memory device is mounted to a front side of said processor card; and

said second memory device is mounted to a rear side of said processor card.

12. The system of claim 11, wherein

said first address pin and said fourth address pin are aligned; and

said second address pin and said third address pin are aligned.

13. The system of claim 9, wherein

said first memory device is a static random access memory; and

said second memory device is a static random access memory.

14. The system of claim 9, wherein

said first memory device further includes a fifth address pin;

said second memory device further includes a sixth address pin; and

said microprocessor is further operable to concurrently provide a third address bit signal to said fifth address pin and said sixth address pin.

15. The system of claim 14, wherein

said fifth address pin and said sixth address pin are functionally dissimilar address pins.

16. The system of claim 14, wherein

said first memory device further includes a seventh address pin;

said second memory device further includes an eighth address; and

said microprocessor is further operable to concurrently provide a fourth address bit signal to said seventh address pin and said eighth address pin.

17. The system of claim 16, wherein

said fifth address pin and said eighth address pin are functionally equivalent address pins; and

said sixth address pin and said seventh address pin are functionally equivalent address pins.

18. The system of claim 16, wherein

said microprocessor includes a multiplexor operable to provide said first address bit signal, said second address bit signal, said third address bit signal, and said fourth address bit signal in response to a control signal indicative of a cache configuration corresponding to said first address bit signal, said second address bit signal, said third address bit signal, and said fourth address bit signal.

19. The system of claim 14, wherein

said microprocessor includes a multiplexor operable to provide said first address bit signal, said second address bit signal, and said third address bit signal in response to a control signal indicative of a cache configuration corresponding to said first address bit signal, said second address bit signal, and said third address bit signal.

20. The system of claim 9, wherein

said microprocessor includes a multiplexor operable to provide said first address bit signal and said second address bit signal in response to a control signal indicative of a cache configuration corresponding to said first address bit signal and said second address bit signal.

21. A method, comprising:

providing a processor board including a first conductor and a second conductor;

providing a first memory device including a first address pin and a second address pin;

providing a second memory device including a third address pin and a fourth address pin, said first address pin and said fourth address pin being functionally equivalent address pins, said second address pin and said third address pin being functionally equivalent address pin;

mounting said first memory device on said processor card, said first address pin contacting said first conductor, said second address pin contacting said second conductor;

mounting a second memory device said processor card, said third address pin contacting said first conductor whereby said first address pin and said third address pin are electrically coupled, said fourth address pin contacting said second conductor whereby said second address pin and said fourth address pin are electrically coupled.

22. The method of claim 21, wherein

said mounting of said first memory device on said processor card includes mounting first memory device said mounted on a front side of said processor card, and

said mounting of said second memory device on said processor card includes mounting said second memory device said mounted on a rear side of said processor card.

23. The method of claim 22, wherein

said mounting of said second memory device said on said processor card includes aligning said first address pin and said third address pin and aligning said second address pin and fourth address pin are aligned.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,760,272 B2
DATED : July 6, 2004
INVENTOR(S) : Franz, Keenan W. and Vaden, Michael T.

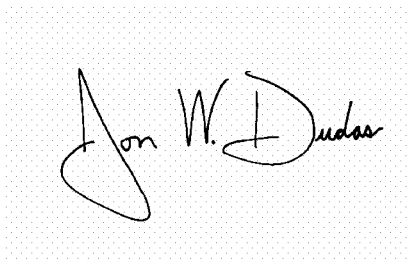
It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 7,
Lines 24-31, please replace claim 16 with:
-- 16. The system of claim 14, wherein
said first memory device further includes a seventh address pin;
said second memory device further includes an eighth address pin; and
said microprocess is further operable to concurrently provide a fourth address bit signal to said seventh address pin and said eighth address pin. --

Column 8,
Line 23, please replace "address pin;" with -- address pins; --

Signed and Sealed this

Twenty-eighth Day of December, 2004



JON W. DUDAS
Director of the United States Patent and Trademark Office