I, Julie Carlson, declare as follows:

1. I have personal knowledge of the facts set forth herein, and if called to testify, I could and would competently testify to the same.

2. I have been involved in semiconductor standardization and publication services for over twenty years. During this time, I have worked at JEDEC, a standards-setting organization for the microelectronics industry, to edit, publish, and maintain JEDEC business records and standards developed by its numerous committees and subcommittees.

3. I have been involved with the standardization and publication activities of JEDEC continuously since 1997. I was the Manager of Standards and Publications at JEDEC from February 1997 through June 2005. After relocating to Maine in 2005, I transitioned to working as a full-time Consultant for JEDEC. Since June 2005, I have continued to work as a Consultant for JEDEC, where my responsibilities include the maintenance and publication of JEDEC documents and standards. I am familiar with JEDEC's historical record-keeping and publication practices since at least 1992, based on my review of JEDEC's business records since that time and my regular discussions with JEDEC employees and members. During my tenure at JEDEC, JEDEC has not changed the system it uses to maintain JEDEC documents.



XILINX EXHIBIT 1012
Page 1

4. As a Consultant, I maintain all documents approved for publishing and have access to all documents at JEDEC. I receive JEDEC documents in draft form and prepare them for publishing. I also edit and help draft JEDEC's manuals of operation and procedure.

5. For over 60 years, JEDEC has been the global leader in developing and publishing open standards for the microelectronics industry. JEDEC's membership consists of more than 3,000 volunteers representing over 350 member companies, and includes key technical individuals from most device, assembly, system, and testing companies. JEDEC publications and standards are adopted worldwide. JEDEC is accredited by ANSI and maintains liaisons with numerous standards bodies throughout the world.

6. Prior to 2000, JEDEC standards were typically available for purchase from JEDEC or approved reseller IHS. Since at least 2000, JEDEC standards have been publicly available for download from the JEDEC website (https://www.jedec.org), where they are cataloged and indexed by keyword and technological subject matter. Most of the standards are free to download, but larger volumes are available for purchase through JEDEC's website and approved reseller IHS.

7. By 2000, the JEDEC website was publicly available and commonly used by manufacturers, companies in the microelectronics industry, and other

interested parties to access and obtain standards information pertaining to that industry. Anyone can register online at JEDEC.org to access free standards and other JEDEC publications. Registration and most published standards are free and selected standards are only available to non-members for a fee. Between approximately 2000 and 2010, a registered user was required to log in before viewing JEDEC's free download area, which featured a list of standards and documents available for download. Around 2010, the website was re-designed so that a log-in was no longer required to visit the free download area and view a list of available standards and documents—instead, login information was only required to view and download a standard or other JEDEC document.

8. To confirm my statements above regarding access to JEDEC documents via JEDEC's website, I have visited the Internet Archive to look at captures of the "FREE Download Area" login and registration pages of JEDEC's website, which occurred on June 15, 2000 and September 1, 2000, respectively: <http://web.archive.org/web/20000615041617/http:/www.jedec.org/DOWNLOAD/default.cfm> and <http://web.archive.org/web/20000901000313/http://www.jedec.org/DOWNLOAD/copyright_agreement.htm>. Printouts of these captures are attached as Exhibits A and B and are consistent with my personal recollection of the JEDEC website. I have also visited the Internet Archive to look at the first capture after the re-design

of JEDEC's website, which occurred on February 24, 2010: <http://web.archive.org/web/20100224045304/http://www.jedec.org/standards-documents/results/field_doc_type%3A%22JESD%22?order=field_doc_full_number_value&sort=asc>. A printout of this capture is attached as Exhibit C and is consistent with my personal recollection of the JEDEC website.

9. This declaration concerns the following standards published by JEDEC:

(1) JEDEC STANDARD, Configurations for Solid State Memories, JEDEC Standard No. 21-C, Release 7 (January 1997) (hereinafter, "JESD21-C Release 7");

(2) JEDEC STANDARD, Double Data Rate (DDR) SDRAM Specification, JESD79, Release 1 (June 2000) (hereinafter, "JESD79 Release 1");

(3) JEDEC STANDARD, Double Data Rate (DDR) SDRAM Specification, JESD79, Release 2 (May 2002) (hereinafter, "JESD79 Release 2");

(4) JEDEC STANDARD, DDR2 SDRAM Specification, JESD79-2A (January 2004) (hereinafter, "JESD79-2A"); and

(5) JEDEC STANDARD, Configurations for Solid State Memories, JEDEC Standard No. 21-C, Release 14 (January 2005) (hereinafter, "JESD21-C Release 14") (collectively, "the JEDEC Standards"). I have reviewed the above JEDEC standards. The copies of the JEDEC Standards attached to this declaration as Exhibits D-H are identical to the copies of the JEDEC Standards in JEDEC's files.

10. The following statements on the public availability of the JEDEC Standards as of their respective publish dates are based on personal knowledge. The development of all JEDEC documents follows the process set forth in JM21: JEDEC Manual of Organization and Procedure. According to that process, the date on the cover of a JEDEC document is the month the document was finalized, approved by legal, and published. For the JESD21-C Release 7, JESD79 Release 1, JESD79 Release 2, JESD79-2A, and JESD21-C Release 14 standards, the dates on the covers (and thus the dates the standards were published and/or posted to JEDEC's website) are January 1997, June 2000, May 2002, January 2004, and January 2005, respectively.

11. I am familiar with the circulation and publication procedures used by JEDEC. Upon approval of the Board of Directors, the JEDEC publications department prepares documents for publication and seeks final review and approval to publish from the JEDEC legal department.

12. Before 2000, once legal approval was received, the JEDEC publications department made the approved document available to the JEDEC membership and members of the public through JEDEC and, for most documents except larger volumes and subscription services, through an approved reseller IHS. For larger volumes, such as JESD21-C, the date on the cover of the Standard indicates the date that it was sent to those with a subscription to the annual updating

service for the volume, in which subscribers would receive the new and/or updated replacement pages of the various modules of the Standard as they were released and insertion instructions for the new and/or updated replacement pages. In addition, copies of the entire volume, as well as any other finalized standard, would have been available for purchase from JEDEC by anyone in the public. The release indicated at the bottom of a given page of larger volumes indicates the release in which that page would have received by subscribers and would have been available for purchase by anyone in the public.

13. Since 2000, once legal approval is received, the JEDEC publications department uploads the approved documents to the JEDEC website with a brief description. When a standard is published on JEDEC's website, it becomes available in the "Standards & Documents" section, where standards are listed by title, document number, and publish date. An email announcement is then sent to the sponsoring committee and any approved resellers.

14. Based on my personal knowledge of JEDEC's policies, the JESD21-C Release 7 Standard was made publicly available in January 1997, consistent with the date notation on the first page of the Standard, through a subscription and availability for purchase by any member of the public, and the JESD79 Release 1, JESD79 Release 2, JESD79-2A, and JESD21-C Release 14 standards were made publicly available via JEDEC's website in June 2000, May 2002, January 2004, and

January 2005, respectively, consistent with the date on the cover page of each respective Standard.

15. Based on my personal knowledge of JEDEC's policies, the JESD21-C Releases 1 through 6 were also publicly available at least by January 1997, when JESD21-C Release 7 was made publicly available, through a subscription and availability for purchase by any member of the public of JESD21-C as an entire volume. Similarly, the JESD21-C Releases 1 through 13 were also publicly available at least by January 2005, when JESD21-C Release 14 was made publicly available, through a subscription and availability for purchase by any member of the public of JESD21-C as an entire volume.

16. My knowledge of the procedures surrounding the creation of the date notation and publication is based on JEDEC's policies and practices as I understand them through my work at JEDEC. I rely on these policies and practices in the course of my work. I have no reason to believe that JEDEC's typical practice was not followed. I have no reason to believe that the JESD21-C Release 7 Standard was not published and made accessible to JEDEC membership and any member of the public in January 1997. I also have no reason to believe that the JESD21-C Release 14 Standard was not published and made accessible to JEDEC membership and any member of the public in January 2005. I also have no reason to believe that the JESD79 Release 1, JESD79 Release 2, and JESD79-2A standards were not

made publicly available via JEDEC's website in June 2000, May 2002, and January 2004, respectively. I also have no reason to believe that the JESD21-C Releases 1 through 6 were not published and made accessible to any member of the public by a subscription or purchase of JESD21-C at least by January 1997, when the JESD-21C Release 7 Standard was made publicly available. I also have no reason to believe that the JESD21-C Releases 1 through 13 were not published and made accessible to any member of the public by a subscription or purchase of JESD21-C at least by January 2005, when the JESD-21C Release 14 Standard was made publicly available.

17. To further confirm my statements above regarding the JESD79 DDR Standard, I visited the Internet Archive to look at the first capture of the JEDEC website after June 2000, which occurred on August 17, 2000: <http://web.archive.org/web/20000817100341/http://www.jedec.org/Default.htm>. A printout of this capture is attached as Exhibit I and is consistent with my personal recollection of the JEDEC website. As shown in Exhibit I, the JESD79 Release 1 "DDR" Standard was featured on the JEDEC homepage, which included a link to the following page captured on August 17, 2000, which allowed anyone to download the JESD79 DDR Standard for "DDR" memory: <http://web.archive.org/web/20000817100514/http:/www.jedec.org/DOWNLOAD/pub21/HotDDR/Default.cfm>. A printout of this capture is attached as Exhibit J

and is consistent with my personal recollection of the JEDEC website. As can be seen from this capture on August 17, 2000, the JESD79 Release 1 DDR Standard was described on the JEDEC website as the "JEDEC Standard 79, Double Data Rate (DDR) SDRAM Specification (datasheet for 64Mb SDRAM)" and was available for download by the public by that date, consistent with my statements above.

18. Exhibit K is a printout of <https://web.archive.org/web/20000711020535/http://www.jedec.org/service_members/New_Members/memberco.htm>, which is a capture on July 11, 2000 of JEDEC's list of member companies as of that date. Exhibit L is a printout of <https://web.archive.org/web/20020605015448/http://www.jedec.org/service_members/New_Members/memberco.htm>, which is a capture on June 5, 2002 of JEDEC's list of member companies as of that date. Exhibit M is a printout of <https://web.archive.org/web/20040202081543/http://jedec.org:80/service_members/New_Members/memberco.cfm>, which is a capture on February 2, 2004 of JEDEC's list of member companies as of that date. Exhibit N is a printout of <https://web.archive.org/web/20051024132448/http://www.jedec.org:80/service_members/New_Members/memberco.cfm>, which is a capture on October 24, 2005 of JEDEC's list of member companies as of that date. Exhibits K, L, M, and N are consistent with my personal recollection of JEDEC's membership. The member

companies listed in Exhibit K would have had access to JESD79 Release 1 by no later than July 11, 2000. The member companies listed in Exhibit L would have had access to JESD79 Release 2 by no later than June 5, 2002. The member companies listed in Exhibit M would have had access to JESD79-2A by no later than February 2, 2004. Lastly, the members listed in Exhibit N would have had access to JESD21-C Release 14 no later than October 24, 2005.

I, Julie Carlson, do hereby declare and state that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, under Section 1001 of Title 18 of the United States Code.

Executed on 1/27/2023



Julie D. Carlson

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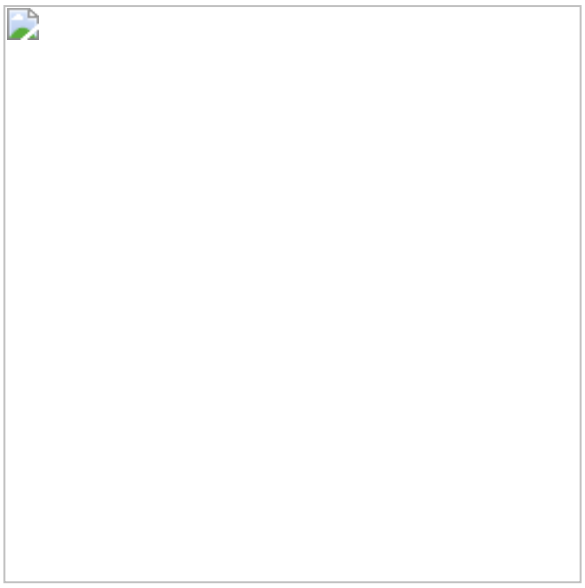
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| LEADLESS CHIP CARRIER PINOUTS STANDARDIZED FOR LINEARS: | JESD1 | Apr 1982 |

This standard shows how to convert existing DIP pinouts for op-amps, comparators, and D/A converters, to chip carrier packages.

Committee(s): JC-41

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| LOW FREQUENCY POWER TRANSISTORS:Status: Reaffirmed September 1981, October 2002 | JESD10 | Jan 1976 |

This standard consists of a listing of letter symbols, terms, and definitions that are used in power transistors. It also includes information on JEDEC registration procedures, verification tests, and thermal characteristics.

Committee(s): JC-25

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| TERMS, DEFINITIONS, AND LETTER SYMBOLS FOR MICROCOMPUTERS, MICROPROCESSORS, AND MEMORY INTEGRATED CIRCUITS: | JESD100B.01 | Dec 2002 |

A revised reference for technical writers and educators, manufacturers, buyers and users of microprocessors, microcomputers, mircocontrollers, memory ICs, and other complex devices. The terms and their definitions in this standard have been updated and are in general agreement with the latest publications of the IEEE and the IEC. The companion standard for other integrated circuits is JESD99A. Also included is a system for generating symbols for time intervals found in complex sequential circuits, including memories. JESD100B.01 is the first minor revision of JESD100-B, December 1999. Annex A briefly shows entries that have changed.

Committee(s): JC-10

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| CHIP CARRIER PINOUTS STANDARDIZED FOR CMOS 4000, HC AND HCT SERIES OF LOGIC CIRCUITS: | JESD11 | Dec 1984 |

This standard indicates the procedures used to convert existing DIP and flat packages for digital parts (SSI & MSI) to chip carrier packages.

Committee(s): JC-40.2

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| SEMICUSTOM INTEGRATED CIRCUITS (FORMERLY PUBLISHED AS STANDARD FOR GATE ARRAY BENCHMARK SET): | JESD12 | Jun 1985 |

The purpose of these benchmarks is to provide a common set of high level functions which serve as vehicles for comparing the performance of gate arrays implemented in any technology using any internal structure. These benchmarks effectively provide an unbiased measure of gate array vendors' ability to implement a desired complex function on a particular gate array at a known level of performance.

Committee(s): JC-44

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| ADDENDUM No. 1 to JESD12 - TERMS AND DEFINITIONS FOR GATE ARRAYS AND CELL-BASED INTEGRATED CIRCUITS: | JESD12-1B | Aug 1993 |

The purpose of this standard is to promote the uniform use of abbreviations, terms, and definitions throughout the semiconductor industry. It is a useful guide for users, manufactures, educators, technical writers, and others interested in the characterization, nomenclature, and classification of semicustom integrated circuits.

Committee(s): JC-44

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| ADDENDUM No. 2 to JESD12 - STANDARD FOR CELL-BASED INTEGRATED CIRCUIT BENCHMARK SET: | JESD12-2 | Feb 1986 |

The purpose of these benchmarks is to provide a common set of high level functions that serve as vehicles for comparing the performance of cell-based ICs implemented in any technology using any internal structure. JESD12-2 extends the gate array benchmark set (JESD12) to cell-based ICs.

Committee(s): JC-44

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| ADDENDUM No. 3 to JESD12 - CMOS GATE ARRAY MACROCELL STANDARD: | JESD12-3 | Jun 1986 |

This standard defines a minimum set of macro cell standards for CMOS gate arrays. A total of 41 macro cell types are addressed, all of which are commonly used by gate array designers to implement Application Specific Integrated Circuits.

Committee(s): JC-44

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| ADDENDUM No. 4 to JESD12 - METHOD OF SPECIFICATION OF PERFORMANCE PARAMETERS FOR CMOS SEMICUSTOM INTEGRATED CIRCUITS: | JESD12-4 | Apr 1987 |

This standard defines how to specify various performance parameters of semicustom ICs, including cell and interconnect propagation delays, input/output levels and capacitance, and power dissipation.

Committee(s): JC-44

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| ADDENDUM No. 5 to JESD12 - DESIGN FOR TESTABILITY GUIDELINES: | JESD12-5 | Aug 1988 |

This standard is intended to provide circuit designers with the information needed to develop complex integrated circuits that can be reliably and economically tested without compromising flexibility.

Committee(s): JC-44

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| ADDENDUM No. 6 to JESD12 - INTERFACE STANDARD FOR SEMICUSTOM INTEGRATED CIRCUITS: | JESD12-6 | Mar 1991 |

This standard defines logic interface levels for CMOS, TTL, ECL, and BiCC inputs and outputs. This standard is intended to provide an industry-wide set of specifications, for Application Specific Integrated Circuit (ASIC) signal inputs and outputs, both necessary and sufficient to define a circuits electrical interfacing with the external environment. JESD12-6 is intended to provide the ASIC manufacturer and user with a common set of signal interface levels. The standard defines interface levels for 5 volt operation.

Committee(s): JC-44

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| STANDARD SPECIFICATION FOR DESCRIPTION OF B SERIES CMOS DEVICES: | JESD13-B | May 1980 |

This standard provides for uniformity, multiplicity of sources, elimination of confusion, and ease of device specifications and system design by users. It gives electrical levels and timing diagrams for B Series CMOS devices.

Committee(s): JC-40.2

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| SEMICONDUCTOR POWER CONTROL MODULES:Status: Reaffirmed June 1992, April 1999, April 2002 | JESD14 | Nov 1986 |

Semiconductor Power Control Modules (SPCM) are modules consisting of thyristors or transistors, or both, as the primary controlling elements. Methods of manufacture of semiconductor power control modules include the assembling of individual components and the use of semiconductor hybrids or monolithic processing technologies, or both.

Committee(s): JC-22.2

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| THERMAL MODELING OVERVIEW | JESD15 | Oct 2008 |

This document and the associated series of documents are intended to promote the continued development of modeling methods, while providing a coherent framework for their use by defining a common vocabulary to discuss modeling, creating requirements for what information should be included in a thermal modeling report, and specifying modeling procedures, where appropriate, and validation methods. This document provides an overview of the methodology necessary for performing meaningful thermal simulations for packages containing semiconductor devices. The actual methodology components are contained in separate detailed documents.

Committee(s): JC-15.1, JC-15

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| COMPACT THERMAL MODEL OVERVIEW | JESD15-1 | Oct 2008 |

This document should be used in conjunction with the master document, JESD15, and JESD15-2, and subsidiary documents as they become available. This document is intended to function as an overview to support the effective use of Compact Thermal Model (CTM) methodologies as specified in the companion methods documents. At present, there are two such documents; JESD15-3, and JESD15-4.

Committee(s): JC-15.1, JC-15

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| TWO-RESISTOR COMPACT THERMAL MODEL GUIDELINE | JESD15-3 | Jul 2008 |

This document specifies the definition and construction of a two-resistor compact thermal model (CTM) from the JEDEC junction-to-case and junction-to-board thermal metrics. The guidance provided in this document only applies to thermal metrics defined in JEDEC standards JESD51-8 and JESD51-12. The scope of this document is limited to single-die packages that can be effectively represented by a single junction temperature.

Committee(s): JC-15

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| DELPHI COMPACT THERMAL MODEL GUIDELINE | JESD15-4 | Oct 2008 |

This guideline specifies the definition and lists acceptable approaches for constructing a compact thermal model (CTM) based on the DELPHI methodology. The purpose of this document is twofold. First, it aims to provide clear guidance to those seeking to create DELPHI compact models of packages. Second, it aims to provide users with an understanding of the methodology by which they are created and validated, and the issues associated with their use.

| Title | Document # | Date |
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Committee(s): JC-15

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| ASSESSMENT OF AVERAGE OUTGOING QUALITY LEVELS IN PARTS PER MILLION (PPM):Status: Reaffirmed September 2008 | JESD16-A | Apr 1995 |

This standard was revised to clarify assumptions necessary to estimate AOQ, revise the minimum sample size algorithm, address small sample size concerns, and provide methods for combining groups for AOQ estimation. Derivation of any new methods for combing groups for AOQ estimation. Derivation of any new methods introduced into this document have been provided in annexes. A statistical method is based on confidence interval statistics. A procedure was established for reporting AOQ when the minimum sample size criterion is not met. Not all sections of EIA-554 are appropriate for use by device manufacturers therefore JEDEC wishes to continue using JESD16A. In December 2008 the formulating committee approved to remove EIA-554 (July 1996, Reaffirmed September 2002) from the JEDEC website. To obtain a copy of EIA-554 please contact GEIA at http://www.geia.org/

Committee(s): JC-13

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| LATCH-UP IN CMOS INTEGRATED CIRCUITS - SUPERSEDED BY JESD78, February 1999Status: Rescinded February 1999 | JESD17 | Aug 1988 |

Committee(s): JC-40.2

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| STANDARD FOR DESCRIPTION OF FAST CMOS TTL COMPATIBLE LOGIC: | JESD18-A | Jan 1993 |

The purpose of this standard is to provide for uniformity, multiplicity of sources, elimination of confusion, and ease of device specification and design by users. The standard covers specifications for description of '54/74FCTXXXX' series fast CMOS TTL compatible devices.

Committee(s): JC-40.2

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# Exhibit D

# JEDEC STANDARD

## CONFIGURATIONS FOR SOLID STATE MEMORIES

## JEDEC Standard No. 21–C Release 7

## January 1997

ELECTRONIC INDUSTRIES ASSOCIATION
ENGINEERING DEPARTMENT









XILINX EXHIBIT 1012
Page 29

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JESD 21–C, Release 7 Insertion Instructions
Instructions for adding Release 7 to JEDEC Standard 21–C.
Inclosed with this instruction sheet are new and replacement pages for JEDEC Standard 21–C. Those pages which contain new material are labeled "Release 7" at the bottom of the page. In some cases, there will be old material on the back of the sheet containing a Release 7 page. This old material will be labeled Release 1, Release 2, Release 3, Release 4, Release 5. or Release 6 as there are no changes from the original release. All new text is marked by a "Revision Bar" in the outside margin in addition to the "Release 7" label in the inside footer of the page.

In this release, I have introduced a new feature in the Release #. In the past when an older sheet was replaced with a new one, either to make a correction, or to revise the original sheet, the new release number simply replaced the old number, thus loosing the information of the original release number. In this release, the old number will be retained followed by the letter "c" for correction, or "r" for revised, this followed by the new release number (e.f 4c7 or 6r7)

The following is a series of sheet by sheet instructions to be used to print the pages for this release. The instruction numbers correspond directly the instructions intended for the holders of the Standard. These are also included with the new originals for R–6. These instructions should be included as the first pages in Release 6. In the printing instructions, the Release # s are refered to as R#.
In the following 75 instructions, the material is arranged in 3 columns. The first column tells which sheet to remove from the 21–C binder. The second column tells which sheet to add to the binder. The third column gives an explanation of the reason for the change or addition.

| | REMOVE | ADD | REASON |
|---|---|---|---|
| 1. | Remove Cover Page | Add replacement Cover Page | Contains new Release level and date. |
| 2. | Remove Title Page; | Add replacement Title Page: | Contains revision Log for Standard. |
| 3. | Remove TOC, 8 sheets; | Add replacement TOC, 9 sheets; | Revised Table of Contents |
| 4. | Remove PP 2–3/4 | Add replacement PP 2–3/4 | New definitions added |
| 5. | Remove PP 2–5/6 | Add replacement PP 2–5/6 | |
| 6. | Remove PP 2–7/8 | Add replacement PP 2–7/8 | New material added. |
| 7. | Remove PP 2–9/10 | Add replacement PP 2–9/10 | New material added. |
| 8. | Remove P 3.5.1–3 | Add replacement PP 3.5.1–3/4 | New standards added |
| 9. | | Add new PP 3.5.1–33/34 | New standard added |
| 10. | Remove P 3.5.2–3 | Add replacement P 3.5.2–3 | New standards added |
| 11. | Remove P 3.5.2–9 | Add replacement PP 3.5.2–9/10 | New devices added to existing standard. |
| 12. | | Add new P 3.5.2–11 | New standard |
| 13. | Remove P 3.5.3–1 | Add replacement P 3.5.3–1/2 | Section re–orgainzed |
| 14. | Remove P 3.5.3–3/4 | Add replacement PP 3.5.3–3/4 | New standards added. |
| 15. | Remove P 3.5.3–5/6 | Add replacement PP 3.5.3–5/6 | New standard added |
| 16. | Remove P 3.5.3–7/8 | Add replacement P 3.5.3–7/8 | New standards added |
| 17. | | Add new P 3.5.3–9/10 | New standards added |
| 18. | | Add new P 3.5.3–11/12 | New standards added |
| 19. | | Add new P 3.5.3–13/14 | New standards added |
| 20. | | Add new P 3.5.3–15 | New standards added |
| 21. | Remove P 3.7.5–1/2 | Add replacement PP 3.7.5–1/2 | New standards added. |
| 22. | Remove P 3.7.5–3/4 | Add replacement PP 3.7.5–3/4 | New standards added. |
| 23. | Remove P 3.7.5–25/26 | Add replacement PP 3.7.5–25/26 | Errors corrected |
| 24. | Remove P 3.7.7–15/16 | Add replacement PP 3.7.7–15/16 | Errors corrected |
| 25. | Remove P 3.7.8–3 | Add replacement P 3.7.8–3 | Existing standard modified. |

| | | | |
|---|---|---|---|
| 26. | Remove PP 3.7.8–9/10 | Add replacement PP 3.7.8–9/10 | New device added. |
| 27. | | Add new P 3.7.8–11 | New standards added |
| 28. | Remove P 3.9.1–15/16 | Add replacement PP 3.9.1–15/16 | New standards added. |
| 29. | Remove P 3.9.2–3/4 | Add replacement PP 3.9.2–3/4 | New standards added. |
| 30. | Remove PP 3.9.2–15/16 | Add replacement PP 3.9.2–15/16 | Modified drawing of existing standard. |
| 31. | Remove PP 3.9.2–17/18 | Add replacement PP 3.9.2–17/18 | Modified drawing of existing standard |
| 32. | | Add new PP 3.9.2–19 | New standard. |
| 33. | Remove P 3.9.3–11/12 | Add replacement P 3.9.3–11/12 | Standard modified. |
| 34. | Remove P 3.9.4–3/4 | Add replacement PP 3.9.4–3/4 | New standards added. |
| 35. | Remove P 3.9.4–13/14 | Add replacement PP 3.9.4–13/14 | New standards added. |
| 36. | | | |
| 37. | Remove P 3.9.5–3 | Add replacement P 3.9.5–3 | New standards added. |
| 38. | Remove P 3.9.5–15/16 | Add replacement PP 3.9.5–15/16 | New standard added. |
| 39. | Remove P 3.10.3–1/2 | Add replacement PP 3.10.3–1/2 | New standards added. |
| 40. | Remove P 3.10.3–5/6 | Add replacement PP 3.10.3–5/6 | Correct error. |
| 41. | | Add new PP 3.10.3–9 | New standards added. |
| 42. | Remove PP 3.10.4–3/4 | Add replacement PP 3.10.4–3/4 | New standards added |
| 43. | Remove PP 3.10.4–17/18 | Add replacement PP 3.10.4–17/18 | New standards added |
| 44. | Remove PP 3.10.4–19/20 | Add replacement PP 3.10.4–19/20 | New standards added |
| 45. | | Add new PP 3.10.4–21 | New standards added |
| 46. | Remove P 3.11.2–1 | Add replacement P 3.11.2–1 | New standard added. |
| 47. | Remove P 3.11.2–3/4 | Add replacement PP 3.11.2–3/4 | Existing standard modified. |
| 48. | | Add new PP 3.11.2–5 | New standards added |
| 49. | Remove P 3.11.3–1 | Add replacement P 3.11.3–1 | New standard added. |
| 50. | Remove P 3.11.3–3/4 | Add replacement PP 3.11.3–3/4 | Existing standard modified, new standard added. |
| 51. | | Add new PP 3.11.3–5 | New standards added |
| 52. | Remove P 3.11.4–1 | Add replacement P 3.11.4–1/2 | Standards revised. |
| 53. | Remove P 3.11.4–3/4 | Add replacement PP 3.11.4–3/4 | Standards revised. |
| 54. | Remove P 3.11.4–5/6 | Add replacement PP 3.11.4–5/6 | Standards revised. |
| 55. | Remove P 3.11.4–7/8 | Add replacement PP 3.11.4–7/8 | Standards revised, correct error. |
| 56. | | Add new PP 3.11.4–9 | New standards added. |
| 57. | Remove PP 3.11.5–7/8 | Add replacement PP 3.11.5–7/8 | Correct error. |
| 58. | Remove PP 3.11.5–9/10 | Add replacement PP 3.11.5–9/10 | Terminology corrections. |

**Section 4 on Modules has been completely re–organized. Remove and discard all of the old pages from Section 4 and replace them with the new ones supplied. No sub–dividers are supplied, but it will enhance the usability of the section by adding your own dividers. The individual sheets are not listed here as they are supplied in correct order for insertion.**

# JEDEC STANDARD

## CONFIGURATIONS FOR SOLID STATE MEMORIES

## JEDEC Standard No. 21–C
## Release 7

**January 1997**

ELECTRONIC INDUSTRIES ASSOCIATION
ENGINEERING DEPARTMENT



XILINX EXHIBIT 1012
Page 35

# CONFIGURATIONS FOR SOLID STATE MEMORIES

Formulated under the cognizance of Committees JC–42.1, PLD devices, JC–42.3, volatile memories, JC–42.4, non–volatile memories, and JC–42.5, memory modules and cards, and approved by the JEDEC Council.

**Standard 21–C Revision Log.**

**Release 1, August 1990**

**Release 2, September 1991**

**Release 3, November 1992**

**Release 4, November 1993**

**Release 5, February 1995**

**Release 6, January 1996**

**Release 7, January 1997**

# Contents


| Section | Release # | Page # |
|---|---|---|
| 1 BACKGROUND | Release 1 | Page 1 – 1 |
| 2 TERMS AND DEFINITIONS | Release 1 | Page 2 – 1 |
| 2.1 Conventional Device Pin Names | Release 6 | Page 2 – 2 |
| 2.2 Multiport DRAM Pin Names | Release 3 | Page 2 – 5 |
| 2.3 Power Pin Names | Release 5 | Page 2 – 6 |
| 2.4 Device Type Names | Release 6 | Page 2 – 7 |
| 2.5 Miscellaneous Device Related Terms | Release 1 | Page 2 – 9 |
| 2.6 Special Operational Cycles for MPDRAM | Release 1 | Page 2 – 10 |
| 2.7 Package–Related Terms | Release 5 | Page 2 – 12 |
| 2.8 Memory Card Pin Names | Release 3 | Page 2 – 13 |
| 2.9 SRAM and SSRAM special Pin Names | Release 6 | Page 2–14 |
| 3 MEMORY DEVICE STANDARDS | Release 1 | Page 3 – 1 |
| 3.1 General Standards | Release 1 | Page 3 .1 –1 |
| 3.1.1 Bytewide | Release 1 | Page 3 .1 –1 |
| 3.1.1.1 – 32K TO 256K BY 8 A/A MX FAMILY IN DIP | Release 1 | Page 3 .1 –1 |
| FIGURE 3.1–1, 32K TO 256K A/A MULTIPLEXED MEMORY IN DIP | Release 1 | Page 3 .1 –2 |
| 3.2 Read Only Memory (ROM) | Release 1 | Page 3.2–1 |
| 3.2.0 ROM General Standards | Release 5 | Page 3.2–2 |
| 3.2.0.1 – Mask ROM Fast Address Mode Definition | Release 5 | Page 3.2–2 |
| 3.2.1 ROM, Byte Wide | Release 1 | Page 3.2.1–1 |
| 3.2.1.1 – 2K TO 8K BY 8 ROM FAMILY IN DIP, TYPE A | Release 1 | Page 3.2.1–1 |
| 3.2.1.2 – 4K BY 8 ROM IN DIP, Type B | Release 1 | Page 3.2.1–1 |
| 3.2.1.3 – 8K TO 128K BY 8 ROM FAMILY IN DIP, | Release 1 | Page 3.2.1–1 |
| 3.2.1.4 – 2K TO 32K BY 8 ROM FAMILY IN RCC | Release 1 | Page 3.2.1–1 |
| 3.2.1.5 – 32K TO 512K BY 8 ROM FAMILY IN SOJ, | Release 1 | Page 3.2.1–1 |
| 3.2.1.6 – 128K TO 1M BY 8 ROM IN DIP, | Release 1 | Page 3.2.1–1 |
| 3.2.1.7 – 64K TO 512K BY 9 ROM IN DIP, | Release 1 | Page 3.2.1–1 |
| 3.2.1.8 – 2 TO 64 X 16K BY 8 PAGE SELECT ROM IN DIP, | Release 1 | Page 3.2.1–1 |
| 3.2.1.9 – 512K and 1M BY 8 ROM IN QFP, | Release 2 | Page 3.2.1–1 |
| FIGURE 3.2.1–1, 2K TO 8K BY 8 ROM IN DIP, TYPES A & B | Release 1 | Page 3.2.1–2 |
| FIGURE 3.2.1–2, 8K TO 128K BY 8 ROM IN DIP | Release 1 | Page 3.2.1–3 |
| FIGURE 3.2.1–3, 2K TO 32K BY 8 ROM IN CC | Release 1 | Page 3.2.1–4 |
| FIGURE 3.2.1–4, 32K TO 512K BY 8 ROM IN SOJ | Release 1 | Page 3.2.1–5 |
| FIGURE 3.2.1–5, 128K TO 1M BY 8 ROM IN DIP | Release 1 | Page 3.2.1–6 |
| FIGURE 3.2.1–6, 64K TO 512K BY 9 ROM IN DIP | Release 1 | Page 3.2.1–7 |
| FIGURE 3.2.1–7, 2 TO 64 X 16K BY 8 PAGE SELECT | Release 1 | Page 3.2.1–8 |
| FIGURE 3.2.1–8, 512K AND 1M BY 8 ROM IN QFP | Release 2 | Page 3.2.1–9 |
| 3.2.2 ROM, Word Wide | Release 1 | Page 3.2.2–1 |
| 3.2.2.1 – 32K TO 256K BY 16 ROM IN DIP | Release 1 | Page 3.2.2–3 |
| 3.2.2.2 – 32K TO 256K BY 16 ROM IN SCC | Release 1 | Page 3.2.2–3 |
| 3.2.2.3 – 16K TO 256K BY 16 ADDRESS/DATA MX ROM IN DIP | Release 1 | Page 3.2.2–3 |
| 3.2.2.4 – 16K TO 256K BY 16 ADDRESS/DATA MX ROM IN RCC | Release 1 | Page 3.2.2–3 |
| 3.2.2.5 – 256K and 512K BY 16 ROM IN QFP | Release 2 | Page 3.2.2–3 |
| 3.2.2.6 – 512K TO 128M BY 16 ROM IN DIP AND SOP | Release 6 | Page 3.2.2–3 |
| 3.2.2.7 – 512K and 1M BY 16 ROM IN SCC | Release 3 | Page 3.2.2–3 |
| FIGURE 3.2.2–1, 32K TO 256K BY 16 ROM IN DIP | Release 1 | Page 3.2.2–5 |
| FIGURE 3.2.2–2, 32K TO 256K BY 16 ROM IN CC | Release 1 | Page 3.2.2–6 |




XILINX EXHIBIT 1012
Page 39

| Section | Release # | Page # |
|---|---|---|
| FIGURE 3.2.2–3, 16K TO 256K BY 16 AQ MX ROM IN DIP | Release 1 | Page 3.2.2–7 |
| FIGURE 3.2.2–4, 16K TO 256K BY 16 AQ MX ROM IN CC | Release 1 | Page 3.2.2–8 |
| FIGURE 3.2.2–5, 256K AND 512K BY 16 ROM IN QFP | Release 2 | Page 3.2.2–9 |
| FIGURE 3.2.2–6, 4M TO 128M BY 16 ROM IN DIP AND SOP | Release 2 | Page 3.2.2–10 |
| FIGURE 3.2.2–7, 512K & 1M BY 16 ROM IN SCC | Release 3 | Page 3.2.2–11 |
| FIGURE 3.2.2–8, 512K TO 2M BY 16 ROM IN DIP AND SOG | Release 6 | Page 3.2.2–12 |
| **3.3 Programmable Read Only Memory (PROM)** | **Release 1** | **Page 3.3–1** |
| **3.3.1 PROM, Nibble Wide** | **Release 1** | **Page 3.3.1–1** |
| 3.3.1.1 – .25K & .5K BY 4 TTL PROM IN DIP | Release 1 | Page 3.3.1–3 |
| 3.3.1.2 – .25K BY 4 ECL PROM IN DIP | Release 1 | Page 3.3.1–3 |
| 3.3.1.3 – 1K & 2K BY 4 TTL PROM IN DIP | Release 1 | Page 3.3.1–3 |
| 3.3.1.4 – 1K & 2K BY 4 TTL PROM IN SOP | Release 1 | Page 3.3.1–3 |
| 3.3.1.5 – 4K TO 8K BY 4 TTL PROM IN DIP | Release 2 | Page 3.3.1–3 |
| 3.3.1.6 – .25K TO 2K BY 4 TTL PROM FAMILY IN RCC | Release 1 | Page 3.3.1–3 |
| 3.3.1.7 – 4K BY 4 TTL PROM, 4K BY 4 TTL RPROM IN SCC | Release 1 | Page 3.3.1–3 |
| 3.3.1.8 – 1K TO 8K TTL BY 4 PROM FAMILY IN RCC | Release 1 | Page 3.3.1–3 |
| 3.3.1.9 – 1K TO 8K TTL BY 4 PROM FAMILY IN SCC | Release 1 | Page 3.3.1–3 |
| 3.3.1.10 – 1K TO 4K BY 4 DPROM FAMILIES IN DIP & SCC | Release 1 | Page 3.3.1–4 |
| 3.3.1.11 – 1K TO 16K BY 4 ECL PROM FAMILY IN DIP | Release 1 | Page 3.3.1–4 |
| FIGURE 3.3.1–1, .25K TO 2K BY 4 TTL PROM IN DIP | Release 1 | Page 3.3.1–5 |
| FIGURE 3.3.1–2, 256 BY 4 ECL PROM IN DIP | Release 1 | Page 3.3.1–6 |
| FIGURE 3.3.1–3, 1K & 2K BY 4 TTL PROM IN SOG | Release 1 | Page 3.3.1–7 |
| FIGURE 3.3.1–4, 4K AND 8K BY 4 TTL PROM IN DIP | Release 2 | Page 3.3.1–8 |
| FIGURE 3.3.1–5, .25K TO 4K BY 4 TTL PROM FAMILY IN CC | Release 1 | Page 3.3.1–9 |
| FIGURE 3.3.1–6, 1K TO 8K BY 4 TTL PROM IN RCC | Release 1 | Page 3.3.1–10 |
| FIGURE 3.3.1–7, 1K TO 8K BY 4 TTL PROM IN SCC | Release 1 | Page 3.3.1–11 |
| FIGURE 3.3.1–8, 1K TO 4K BY 4 TTL DPROM IN DIP | Release 1 | Page 3.3.1–12 |
| FIGURE 3.3.1–9, 1K TO 4K BY 4 DPROM IN CC | Release 1 | Page 3.3.1–13 |
| FIGURE 3.3.1–10, 1K TO 16K BY 4 ECL PROM IN DIP | Release 1 | Page 3.3.1–14 |
| **3.3.2 PROM, Bytewide** | **Release 1** | **Page 3.3.2–1** |
| 3.3.2.1 – 32 BY 8 TTL PROM IN DIP & SCC | Release 1 | Page 3.3.2–3 |
| 3.3.2.2 – 32 BY 8 ECL PROM IN DIP & SCC | Release 1 | Page 3.3.2–3 |
| 3.3.2.3 – .25K & .5K BY 8 TTL PROM IN DIP & SCC | Release 1 | Page 3.3.2–3 |
| 3.3.2.4 – .25K TO 8K BY 8 TTL PROM FAMILY IN DIP | Release 1 | Page 3.3.2–3 |
| 3.3.2.5 – .5K TO 4K BY 8 TTL LPROM FAMILY IN DIP | Release 1 | Page 3.3.2–3 |
| 3.3.2.6 – .5K TO 4K BY 8 TTL RPROM FAMILY IN DIP | Release 1 | Page 3.3.2–3 |
| 3.3.2.7 – .5K TO 8K BY 8 TTL PROM FAMILIES IN RCC & SCC | Release 1 | Page 3.3.2–3 |
| 3.3.2.8 – .5K TO 2K BY 8 TTL RPROM FAMILY IN SCC | Release 1 | Page 3.3.2–4 |
| 3.3.2.9 – 16K TO 64K BY 8 TTL PROM FAMILY IN DIP | Release 1 | Page 3.3.2–4 |
| 3.3.2.10 – 512 BY 8 ECL RPROM IN DIP & SCC | Release 2 | Page 3.3.2–4 |
| FIGURE 3.3.2–1, 32 BY 8 TTL & ECL PROM IN DIP | Release 1 | Page 3.3.2–5 |
| FIGURE 3.3.2–2, 32, 256, & 512 BY 8 TTL PROM IN CC, 32 BY 8 ECL PROM IN CC | Release 1 | Page 3.3.2–6 |
| FIGURE 3.3.2–3, 256 & 512 BY 8 TTL PROM IN DIP | Release 1 | Page 3.3.2–7 |
| FIGURE 3.3.2–4, .25K TO 8K BY 8 TTL PROM IN DIP | Release 1 | Page 3.3.2–8 |
| FIGURE 3.3.2–5, .5K TO 4K BY 8 TTL LPROM IN DIP | Release 1 | Page 3.3.2–9 |
| FIGURE 3.3.2–6, .5K TO 4K BY 8 TTL RPROM IN DIP | Release 1 | Page 3.3.2–10 |
| FIGURE 3.3.2–7, .5K TO 8K BY 8 TTL PROM IN SCC | Release 1 | Page 3.3.2–11 |
| FIGURE 3.3.2–8, .5K TO 8K BY 8 TTL PROM IN RCC | Release 1 | Page 3.3.2–12 |
| FIGURE 3.3.2–9, .5K TO 2K BY 8 RPROM IN CC | Release 1 | Page 3.3.2–13 |
| FIGURE 3.3.2–10, 16K TO 64K BY 8 TTL PROM IN DIP | Release 1 | Page 3.3.2–14 |
| FIGURE 3.3.2–11, 512 BY 8 10K & 100K ECL RPROM IN DIP AND SCC | Release 2 | Page 3.3.2–15 |


**Release 7**



XILINX EXHIBIT 1012
Page 40

| Section | Release # | Page # |
|---|---|---|
| **3.3.3 PROM, Word Wide** | Release 1 | Page 3.3.3–1 |
| 3.3.3.1 – 32 AND 64 BY 16 PROM IN DIP AND SCC | Release 1 | Page 3.3.3–3 |
| FIGURE 3.3.3–1, 32 AND 64 BY 16 TTL PROM IN DIP | Release 1 | Page 3.3.3–5 |
| FIGURE 3.3.3–2, 32 AND 64 BY 16 TTL PROM IN CC | Release 1 | Page 3.3.3–6 |
| **3.3.4 PROM Package Conversion** | Release 1 | Page 3.3.4–1 |
| 3.3.4.1 – PROM DIP TO SO CONVERSION, 16, 18, 20, 24 DIP | Release 1 | Page 3.3.4–1 |
| FIGURE 3.3.4–1, 1K AND 2K TTL PROM 18 DIP TO 20 SO CONVERSION | Release 1 | Page 3.3.4–3 |
| **3.4 Erasable Programmable Read Only Memory (EPROM)** | Release 1 | Page 3.4–1 |
| **3.4.1 EPROM, Byte Wide** | Release 1 | Page 3.4.1–1 |
| 3.4.1.1 – 4K BY 8 EPROM IN DIP, TYPE A | Release 1 | Page 3.4.1–3 |
| 3.4.1.2 – 4K AND 8K BY 8 EPROM IN DIP, | Release 1 | Page 3.4.1–3 |
| 3.4.1.3 – 8K TO 64K BY 8 EPROM FAMILY IN DIP, | Release 1 | Page 3.4.1–3 |
| 3.4.1.4 – 2K TO 512K BY 8 EPROM FAMILY IN RCC | Release 1 | Page 3.4.1–3 |
| 3.4.1.5 – 32K TO 512K BY 8 EPROM FAMILY IN SOJ, | Release 1 | Page 3.4.1–3 |
| 3.4.1.6 – 128K TO 1M BY 8 EPROM FAMILY IN DIP, | Release 1 | Page 3.4.1–3 |
| 3.4.1.7 – 64K TO 512K BY 9 EPROM FAMILY IN DIP, | Release 1 | Page 3.4.1–3 |
| 3.4.1.8 – 2 TO 64 X 16K BY 8 PAGE SELECT EPROM FAMILY IN DIP, | Release 1 | Page 3.4.1–3 |
| 3.4.1.9 – 128K TO 512K BY 8 EPROM FAMILY IN TSOP–1, | Release 4 | Page 3.4.1–3 |
| FIGURE 3.4.1–1, 4K AND 8K BY 8 EPROM IN DIP, TYPES A & B | Release 1 | Page 3.4.1–5 |
| FIGURE 3.4.1–2, 8K TO 64K BY 8 EPROM IN DIP | Release 1 | Page 3.4.1–6 |
| FIGURE 3.4.1–3, 2K TO 512K BY 8 EPROM IN CC | Release 1 | Page 3.4.1–7 |
| FIGURE 3.4.1–4, 32K TO 512K BY 8 EPROM IN SOJ | Release 1 | Page 3.4.1–8 |
| FIGURE 3.4.1–5, 128K TO 1M BY 8 EPROM IN DIP | Release 1 | Page 3.4.1–9 |
| FIGURE 3.4.1–6, 64K TO 512K BY 9 EPROM IN DIP | Release 1 | Page 3.4.1–10 |
| FIGURE 3.4.1–7, 2 TO 64 X 16K BY 8 PAGE SELECT EPROM IN DIP | Release 1 | Page 3.4.1–11 |
| FIGURE 3.4.1–8, 128K TO 512K BY 8 EPROM IN TSOP–1 | Release 4 | Page 3.4.1–12 |
| **3.4.2 EPROM, Word Wide** | Release 1 | Page 3.4.2–1 |
| 3.4.2.1 – 32K TO 256K BY 16 EPROM IN DIP | Release 1 | Page 3.4.2–3 |
| 3.4.2.2 – 32K TO 256K BY 16 EPROM IN SCC | Release 1 | Page 3.4.2–3 |
| 3.4.2.3 – 16K TO 256K BY 16 ADDRESS/DATA MX EPROM IN DIP | Release 1 | Page 3.4.2–3 |
| 3.4.2.4 – 16K TO 256K BY 16 ADDRESS/DATA MX EPROM IN RCC | Release 1 | Page 3.4.2–3 |
| 3.4.2.5 – 512K TO 128M BY 16 EPROM or OTP IN DIP AND SOP | Release 6 | Page 3.4.2–3 |
| 3.4.2.6 – 512K and 1M BY 16 EPROM IN SCC | Release 3 | Page 3.4.2–3 |
| 3.4.2.7 – 64K TO 256K BY 16 EPROM IN TSOP–1 | Release 4 | Page 3.4.2–3 |
| FIGURE 3.4.2–1, 32K TO 256K BY 16 EPROM IN DIP | Release 1 | Page 3.4.2–5 |
| FIGURE 3.4.2–2, 32K TO 256K BY 16 EPROM IN SCC | Release 1 | Page 3.4.2–6 |
| FIGURE 3.4.2–3, 16K TO 256K BY 16 ADDRESS/DATA MX EPROM IN DIP | Release 1 | Page 3.4.2–7 |
| FIGURE 3.4.2–4, 16K TO 256K BY 16 ADDRESS/DATA MX EPROM IN RCC | Release 1 | Page 3.4.2–8 |
| FIGURE 3.4.2–5, 4M TO 128M BY 16 EPROM OR OTP IN DIP AND SOP | Release 1 | Page 3.4.2–9 |
| FIGURE 3.4.2–6, 512K & 1M BY 16 EPROM IN CC | Release 3 | Page 3.4.2–10 |
| FIGURE 3.4.2–7, 64K BY 256K BY 16 EPROM IN TSOP–1 | Release 4 | Page 3.4.2–11 |
| FIGURE 3.4.2–8, 512K TO 2M BY 16 EPROM IN DIP AND SOG | Release 6 | Page 3.4.2–12 |
| **3.5 Electrically Erasable Programmable Read Only Memory (EEPROM)** | Release 1 | Page 3.5–1 |
| **3.5.1 EEPROM, Byte Wide** | Release 1 | Page 3.5.1–1 |
| 3.5.1.1 – .5K TO 2K BY 8 EEPROM FAMILY IN DIP | Release 1 | Page 3.5.1–2 |
| 3.5.1.2 – 2K & 4K BY 8 EEPROM IN RCC | Release 1 | Page 3.5.1–2 |
| 3.5.1.3 – 1K TO 32K BY 8 EEPROM FAMILY IN DIP | Release 1 | Page 3.5.1–2 |
| 3.5.1.4 – .5K TO 32K BY 8 EEPROM FAMILY IN RCC | Release 1 | Page 3.5.1–2 |
| 3.5.1.5 – 32K TO 256K BY 8 EEPROM FAMILY IN SOJ, | Release 1 | Page 3.5.1–2 |
| 3.5.1.6 – 32K TO 512K BY 8 EEPROM FAMILY IN DIP, | Release 1 | Page 3.5.1–2 |


**Release 7**



XILINX EXHIBIT 1012
Page 41

| Section | Release # | Page # |
|---|---|---|
| 3.5.1.7 – 32K TO 256K BY 8 EEPROM FAMILY IN RCC, | Release 1 | Page 3.5.1–2 |
| 3.5.1.8 – 32K TO 256K BY 9 EEPROM FAMILY IN DIP, | Release 1 | Page 3.5.1–2 |
| 3.5.1.9 – 128K TO 1M BY 8 EEPROM FAMILY IN SCC, | Release 1 | Page 3.5.1–2 |
| 3.5.1.10 – 32K TO 256K BY 8 EEPROM FAMILY IN TSOP1 | Release 2 | Page 3.5.1–3 |
| 3.5.1.11 – EXTENDED FEATURE SET FOR 256K BIT EEPROM | Release 2 | Page 3.5.1–3 |
| 3.5.1.12 – OPTIONAL COMMAND SET FOR DUAL–SUPPLY EEPROM | Release 3 | Page 3.5.1–3 |
| 3.5.1.13 – 512K BY 8 DUAL–SUPPLY EEPROM IN RCC | Release 5 | Page 3.5.1–3 |
| 3.5.1.14 – 128K to 512K BY 8 SINGLE–SUPPLY EEPROM FAMILY IN DIP, RCC, & TSOP1 | Release 5 | Page 3.5.1–3 |
| 3.5.1.15 – 256K, 512K, &1M BY 8 DUAL–SUPPLY EEPROM IN TSOP1 | Release 6 | Page 3.5.1–4 |
| 3.5.1.16 – 1M TO 8M BY 8 SINGLE–SUPPLY EEPROM FAMILY IN TSOP1 | Release 5 | Page 3.5.1–4 |
| 3.5.1.17 – 8K BY 256B OR 264B SERIAL ACCESS EEPROM IN TSOP2 | Release 6 | Page 3.5.1–4 |
| 3.5.1.18 – 1M, 2M BU 8 SINGLE OR DUAL SUPPLY EEPROM IN PSOP2 | Release 7 | Page 3.5.1–4 |
| FIGURE 3.5.1–1, .5K TO 2K BY 8 EEPROM IN DIP | Release 1 | Page 3.5.1–5 |
| FIGURE 3.5.1–2, 2K & 4K BY 8 EEPROM IN RCC | Release 1 | Page 3.5.1–6 |
| FIGURE 3.5.1–3, 1K TO 32K BY 8 EEPROM FAMILY IN DIP | Release 1 | Page 3.5.1–7 |
| FIGURE 3.5.1–4, .5K TO 32K BY 8 EEPROM FAMILY IN RCC | Release 1 | Page 3.5.1–8 |
| FIGURE 3.5.1–5, 32K TO 256K BY 8 EEPROM FAMILY IN SOJ | Release 1 | Page 3.5.1–9 |
| FIGURE 3.5.1–6, 32K TO 512K BY 8 EEPROM FAMILY IN DIP | Release 1 | Page 3.5.1–10 |
| FIGURE 3.5.1–7, 32K TO 256K BY 8 EEPROM FAMILY IN RCC | Release 1 | Page 3.5.1–11 |
| FIGURE 3.5.1–8, 32K TO 256K BY 9 EEPROM FAMILY IN DIP | Release 1 | Page 3.5.1–12 |
| FIGURE 3.5.1–9, 128K TO 1M BY 8 EEPROM FAMILY IN SCC | Release 1 | Page 3.5.1–13 |
| FIGURE 3.5.1–10, 32K TO 256K BY 8 EEPROM FAMILY IN TSOP1 | Release 2 | Page 3.5.1–14 |
| ADDENDUM 1, 32K X 8 BIT EEPROM EXTENDED FEATURE STANDARD | Release 2 | Page 3.5.1–15 |
| FIGURE 3.5.1–11, DUAL SUPPLY EEPROM COMMAND SET | Release 3 | Page 3.5.1–23 |
| FIGURE 3.5.1–12, 512K BY 8 DUAL–SUPPLY EEPROM IN RCC | Release 5 | Page 3.5.1–24 |
| FIGURE 3.5.1–13, 128K to 512K SINGLE–SUPPLY EEPROM FAMILY IN DIP | Release 5 | Page 3.5.1–25 |
| FIGURE 3.5.1–14, 128K to 512K SINGLE–SUPPLY EEPROM FAMILY IN RCC | Release 5 | Page 3.5.1–26 |
| FIGURE 3.5.1–15, 128K to 512K SINGLE–SUPPLY EEPROM FAMILY IN TSOP1 | Release 5 | Page 3.5.1–27 |
| FIGURE 3.5.1–16, 1M BY 8 DUAL–SUPPLY EEPROM IN TSOP1 | Release 5 | Page 3.5.1–28 |
| FIGURE 3.5.1–17. 1M TO 8M SINGLE–SUPPLY EEPROM FAMILY IN TSOP1 | Release 5 | Page 3.5.1–29 |
| FIGURE 3.5.1–18, 256K & 512K BY 8 DUAL–SUPPLY EEPROM IN TSOP1 | Release 6 | Page 3.5.1–30 |
| FIGURE 3.5.1–19 A⇒C 8K BY 256B OR 264B SERIAL ACCESS EEPROM IN TSOP2 | Release 6 | Page 3.5.1–31⇒33 |
| FIGURE 3.5.1–20. 1M, 2M BU 8 SINGLE OR DUAL SUPPLY EEPROM IN PSOP1 | Release 7 | Page 3.5.1–34 |
| **3.5.2 EEPROM, Word Wide** | **Release 1** | **Page 3.5.2–1** |
| 3.5.2.1 – 4K TO 32K BY 16 EEPROM IN DIP | Release 1 | Page 3.5.2–3 |
| 3.5.2.2 – 4K TO 256K BY 16 EEPROM IN SCC | Release 1 | Page 3.5.2–3 |
| 3.5.2.3 – 256K TO 128M BY 16 EEPROM IN DIP AND SOG | Release 6 | Page 3.5.2–3 |
| 3.5.2.4 – 1M TO 4M BY 16 DS EEPROM IN SSOP | Release 6 | Page 3.5.2–3 |
| 3.5.2.5 – 1M TO 4M DENSITY, BY 8 OR 16 FEEPROM IN PSOP | Release 7 | Page 3.5.2–3 |
| 3.5.2.6 – 1M TO 32M DENSITY, BY 8 OR 16 FEEPROM IN TSOP1 | Release 7 | Page 3.5.2–3 |
| FIGURE 3.5.2–1, 4K TO 32K BY 16 EEPROM FAMILY IN DIP | Release 1 | Page 3.5.2–5 |
| FIGURE 3.5.2–2, 4K TO 256K BY 16 EEPROM FAMILY IN SCC | Release 1 | Page 3.5.2–6 |
| FIGURE 3.5.2–3, 4M TO 128M BY 16 EEPROM FAMILY IN DIP AND SOG | Release 2 | Page 3.5.2–7 |
| FIGURE 3.5.2–4, 256K TO 2M BY 16 EEPROM FAMILY IN DIP AND SOG | Release 6 | Page 3.5.2–8 |
| FIGURE 3.5.2–5, 1M TO 4M BY 16 DS EEPROM IN SSOP | Release 6 | Page 3.5.2–9 |
| FIGURE 3.5.2–6, 1M TO 4M DENSITY BY 8 OR16 FEEPROM IN PSOP | Release 7 | Page 3.5.2–10 |
| FIGURE 3.5.2–7, 1M TO 32M DEBSITY BY 8 OR16 FEEPROM IN PSOP | Release 7 | Page 3.5.2–11 |
| **3.5.3 EEPROM EXTENDED FEATURES** | **Release 1** | **Page 3.5.3–1** |
| 3.5.3.1 – EXTENDED FEATURE SET FOR 256Kb EEPROM | Release 1 | Page 3.5.3–3 |
| 3.5.3.2 – DUAL SUPPLY EEPROM COMMAND SET | Release 7 | Page 3.5.3–13 |


**Release 7**



XILINX EXHIBIT 1012
Page 42

| Section | Release # | Page # |
|---|---|---|
| 3.5.3.3 – SINGLE SUPPLY EEPROM COMMAND CODES | Release 7 | Page 3.5.3–14 |
| 3.5.3.4 – EEPROM TOGGLE BIT FEATURE | Release 7 | Page 3.5.3–15 |
| **3.6 Non volatile Random Access Memory (NVRAM)** | **Release 1** | **Page 3.6–1** |
| **3.6.1 NVRAM, Nibble Wide** | **Release 1** | **Page 3.6–3** |
| 3.6.1.1 – .25K & 1K BY 4 NVRAM IN DIP | Release 1 | Page 3.6–3 |
| **3.6.2 NVRAM, BYTE WIDE** | **Release 1** | **Page 3.6–3** |
| 3.6.2.1 – .5K, 1K BY 8 NVRAM IN DIP | Release 1 | Page 3.6–3 |
| 3.6.2.2 – .5K & 1K BY 8 NVRAM IN RCC | Release 1 | Page 3.6–3 |
| 3.6.2.3 – .5K TO 16K BY 8 NVRAM FAMILY IN DIP | Release 1 | Page 3.6–3 |
| 3.6.2.4 – .5K TO 16K BY 8 NVRAM FAMILY IN RCC | Release 1 | Page 3.6–3 |
| 3.6.2.5 – 32K TO 256K BY 8 NVRAM FAMILY IN SOJ, | Release 1 | Page 3.6–3 |
| 3.6.2.6 – 32K TO 256K BY 8 NVRAM FAMILY IN DIP, | Release 1 | Page 3.6–3 |
| 3.6.2.7 – 16K TO 128K BY 9 NVRAM FAMILY IN DIP, | Release 1 | Page 3.6–3 |
| FIGURE 3.6–1, .25K & 1K BY 4 NVRAM IN DIP | Release 1 | Page 3.6–5 |
| FIGURE 3.6–2, .5K & 1K BY 8 NVRAM IN DIP | Release 1 | Page 3.6–6 |
| FIGURE 3.6–3, .5K & 1K BY 8 NVRAM IN RCC | Release 1 | Page 3.6–7 |
| FIGURE 3.6–4, .5K TO 16K BY 8 NVRAM FAMILY IN DIP | Release 1 | Page 3.6–8 |
| FIGURE 3.6–5, .5K TO 16K BY 8 NVRAM FAMILY IN RCC | Release 1 | Page 3.6–9 |
| FIGURE 3.6–6, 32K TO 256K BY 8 NVRAM FAMILY IN SOJ | Release 1 | Page 3.6–10 |
| FIGURE 3.6–7, 32K TO 256K NY 8 NVRAM FAMILY IN DIP | Release 1 | Page 3.6–11 |
| FIGURE 3.6–8, 16K TO 128K BY 9 NVRAM FAMILY IN DIP | Release 1 | Page 3.6–12 |
| **3.7 Static Random Access Memory (SRAM)** | **Release 1** | **Page 3.7–1** |
| **3.7.1 – JTAG Extension to Revolutionary Pinout SRAM Devices** | **Release 4** | **Page 3.7–1** |
| FIGURE 3.7–1, JTAG ADDITION TO REVOLUTIONARY PINOUT SRAM | Release 4 | Page 3.7–3 |
| **3.7.1 Bit Wide TTL SRAM** | **Release 1** | **Page 3.7.1–1** |
| 3.7.1.1 – .25K & 1K BY 1 TTL SRAM IN DIP | Release 1 | Page 3.7.1–3 |
| 3.7.1.2 – .25K & 1K BY 1 TTL SRAM IN SCC | Release 1 | Page 3.7.1–3 |
| 3.7.1.3 – 4K TO 2M BY 1 TTL SRAM FAMILY IN DIP | Release 1 | Page 3.7.1–3 |
| 3.7.1.4 – 16K BY 1 TTL SRAM IN RCC | Release 1 | Page 3.7.1–3 |
| 3.7.1.5 – 64K BY 1 TTL SRAM IN RCC | Release 1 | Page 3.7.1–3 |
| 3.7.1.6 – 16K TO 2M BY 1 TTL SRAM IN SOJ | Release 5 | Page 3.7.1–3 |
| 3.7.1.7 – 256K TO 16M BY 1 TTL SRAM AND 4M BY 1 SSRAM IN DIP, SOJ, AND TSOP–2 | Release 4 | Page 3.7.1–3 |
| 3.7.1.8 – 256K BY 1 TTL SRAM IN RCC | Release 1 | Page 3.7.1–3 |
| 3.7.1.9 – 4M AND 16M SRAM, CONFIGURABLE TO X1 OR X4 IN DIP, SOJ, AND TSOP–2 | Release 4 | Page 3.7.1–3 |
| FIGURE 3.7.1–1, 0.25K & 1K BY 1 TTL SRAM IN DIP | Release 1 | Page 3.7.1–5 |
| FIGURE 3.7.1–2, 0.25K & 1K BY 1 TTL SRAM IN SCC | Release 1 | Page 3.7.1–6 |
| FIGURE 3.7.1–3, 4K TO 2M BY 1 TTL SRAM FAMILY IN DIP | Release 1 | Page 3.7.1–7 |
| FIGURE 3.7.1–4, 16K BY 1 TTL SRAM IN RCC | Release 1 | Page 3.7.1–8 |
| FIGURE 3.7.1–5, 64K BY 1 TTL SRAM IN RCC | Release 1 | Page 3.7.1–9 |
| FIGURE 3.7.1–6, 16K TO 2M BY 1 TTL SRAM IN SOJ AND TSOP–2 | Release 5 | Page 3.7.1–10 |
| FIGURE 3.7.1–7, 256K TO 16M BY 1 TTL SRAM AND SSRAM FAMILY IN DIP, TSOP2, AND SOJ | Release 4 | Page 3.7.1–11 |
| FIGURE 3.7.1–8, 256K BY 1 TTL SRAM IN RCC | Release 1 | Page 3.7.1–12 |
| FIGURE 3.7.1–9, 4M AND 16M CONFIGURABLE SRAM IN DIP, TSOP2, AND SOJ | Release 4 | Page 3.7.1–13 |
| **3.7.2 Bit Wide ECL SRAM** | **Release 1** | **Page 3.7.2–1** |
| 3.7.2.1 – 1K TO 256K BY 1 ECL SRAM FAMILY IN DIP | Release 1 | Page 3.7.2–3 |
| 3.7.2.2 – 256K TO 16M BY 1 ECL SRAM AND 4M BY 1 SSRAM IN DIP, SOJ, AND TSOP–2 | Release 4 | Page 3.7.2–3 |
| 3.7.2.3 – 64K AND 256K BY 1 ECL SRAM IN FLATPACK | Release 2 | Page 3.7.2–3 |


**Release 7**



XILINX EXHIBIT 1012
Page 43

| Section | Release # | Page # |
|---|---|---|
| 3.7.2.4 – 256K TO 16M BY 1 ECL SSRAM FAMILY IN DIP, SOJ, AND TSOP–2 | Release 4 | Page 3.7.2–3 |
| FIGURE 3.7.2–1, 1K TO 256K BY 1 ECL SRAM FAMILY IN DIP | Release 1 | Page 3.7.2–5 |
| FIGURE 3.7.2–2, 256K TO 16M BY 1 ECL SRAM AND SSRAM FAMILY IN DIP, TSOP2, & SOJ | Release 4 | Page 3.7.2–6 |
| FIGURE 3.7.2–3, 64K AND 256K BY 1 ECL SRAM IN FP | Release 2 | Page 3.7.2–7 |
| FIGURE 3.7.2–4, 256K TO 16M BY 1 ECL SSRAM FAMILY IN DIP, TSOP2, & SOJ | Release 4 | Page 3.7.2–8 |
| **3.7.3 Nibble Wide TTL SRAM** | **Release 1** | **Page 3.7.3–1** |
| 3.7.3.1 – 16 BY 4, INVERTING AND NON INVERTING TTL SRAM IN DIP & SCC | Release 1 | Page 3.7.3–3 |
| 3.7.3.2 – .25K BY 4 TTL SRAM IN DIP & RCC | Release 1 | Page 3.7.3–3 |
| 3.7.3.3 – 256 BY 4 TTL SRAM WITH G IN SCC | Release 1 | Page 3.7.3–3 |
| 3.7.3.4 – 4K TO 64K BY 4 TTL SRAM WITHOUT G FAMILY IN DIP | Release 1 | Page 3.7.3–3 |
| 3.7.3.5 – 4K BY 4 TTL SRAM IN RCC | Release 1 | Page 3.7.3–3 |
| 3.7.3.6 – 4K TO 1M BY 4 TTL SRAM WITH G FAMILY IN DIP | Release 1 | Page 3.7.3–3 |
| 3.7.3.7 – 16K TO 256K BY 4 TTL SRAM WITH AND WITHOUT G FAMILY IN RCC | Release 1 | Page 3.7.3–3 |
| 3.7.3.8 – 16K & 64K BY 4 TTL SRAM IN RCC | Release 1 | Page 3.7.3–3 |
| 3.7.3.9 – 4K TO 1M BY 4 TTL SRAM WITH AND WITHOUT G FAMILY IN SOJ AND TSOP–2 | Release 5 | Page 3.7.3–4 |
| 3.7.3.10 – 64K TO 4M BY 4 TTL SRAM IN DIP, SOJ, AND TSOP–2 | Release 4 | Page 3.7.3–4 |
| 3.7.3.11 – 64K TO 4M BY 4 TTL SRAM WITH SEPARATE DATA I/O IN DIP, SOJ, AND TSOP–2 | Release 4 | Page 3.7.3–4 |
| 3.7.3.12 – 64K TO 4M BY 4 SYNCHRONOUS SRAM (SSRAM) IN DIP, SOJ, AND TSOP–2 | Release 4 | Page 3.7.3–4 |
| 3.7.3.13 – 4K AND 16K BY 4 CACHE TAG SRAM IN DIP AND SOJ | Release 1 | Page 3.7.3–4 |
| 3.7.3.14 – 4M AND 16M SRAM, CONFIGURABLE TO X1 OR X4 IN DIP AND SOJ | Release 1 | Page 3.7.3–4 |
| FIGURE 3.7.3–1, 16 BY 4 INVERTING AND NON–INVERTING TTL SRAM IN DIP | Release 1 | Page 3.7.3–5 |
| FIGURE 3.7.3–2, 16 BY 4 INVERTING AND NON–INVERTING TTL SRAM IN SCC | Release 1 | Page 3.7.3–6 |
| FIGURE 3.7.3–3, 256 BY 4 TTL SRAM IN DIP | Release 1 | Page 3.7.3–7 |
| FIGURE 3.7.3–4, 256 BY 4 TTL SRAM IN RCC | Release 1 | Page 3.7.3–8 |
| FIGURE 3.7.3–5, 256 BY 4 TTL SRAM IN SCC | Release 1 | Page 3.7.3–9 |
| FIGURE 3.7.3–6, 4K TO 64K BY 4 TTL SRAM FAMILY WITHOUT G IN DIP | Release 1 | Page 3.7.3–10 |
| FIGURE 3.7.3–7, 4K BY 4 TTL SRAM IN RCC | Release 1 | Page 3.7.3–11 |
| FIGURE 3.7.3–8, 4K TO 256K BY 4 TTL SRAM FAMILY WITH G IN DIP | Release 1 | Page 3.7.3–12 |
| FIGURE 3.7.3–9, 16K TO 256K BY 4 TTL SRAM FAMILY IN RCC | Release 1 | Page 3.7.3–13 |
| FIGURE 3.7.3–10, 16K & 64K BY 4 TTL SRAM IN RCC | Release 1 | Page 3.7.3–14 |
| FIGURE 3.7.3–11, 4K TO 1M BY 4 TTL SRAM WITH AND W/O G IN SOJ AND TSOP–2 | Release 1 | Page 3.7.3–15 |
| FIGURE 3.7.3–12, 64K TO 4M BY 4 TTL SRAM FAMILY IN DIP, TSOP2, AND SOJ | Release 4 | Page 3.7.3–16 |
| FIGURE 3.7.3–13, 64K TO 4M BY 4 TTL SRAM FAMILY WITH SEPARATE DATA I/O IN DIP, TSOP2, AND SOJ | Release 4 | Page 3.7.3–17 |
| FIGURE 3.7.3–14, 64K TO 4M BY 4 SYNCHRONOUS SRAM (SSRAM) FAMILY IN DIP,SOJ,AND TSOP–2 | Release 4 | Page 3.7.3–18 |
| FIGURE 3.7.3–15, 4K AND 16K BY 4 CACHE TAG SRAM IN DIP AND SOJ | Release 1 | Page 3.7.3–19 |
| **3.7.4 Nibble Wide ECL SRAM** | **Release 1** | **Page 3.7.4–1** |
| 3.7.4.1 – .25K AND 1K BY 4, 100K ECL SRAM IN DIP AND SFP | Release 1 | Page 3.7.4–3 |
| 3.7.4.2 – 1K TO 16K BY 4, 10K & 100K ECL SRAM IN DIP | Release 1 | Page 3.7.4–3 |
| 3.7.4.3 – .25K TO 16K BY 4, 10K & 100K ECL SRAM FAMILY IN DIP | Release 1 | Page 3.7.4–3 |
| 3.7.4.4 – 16K BY 4,10K & 100K ECL SSRAM IN DIP | Release 1 | Page 3.7.4–3 |
| 3.7.4.5 – 64K TO 4M BY 4 ECL SRAM IN DIP, SOJ, AND TSOP–2 | Release 4 | Page 3.7.4–3 |
| 3.7.4.6 – 64K TO 4M BY 4 ECL SRAM WITH SEPARATE DATA I/O IN DIP, SOJ, AND TSOP–2 | Release 4 | Page 3.7.4–3 |




XILINX EXHIBIT 1012
Page 44

| Section | Release # | Page # |
|---|---|---|
| , 3.7.4.7 – 64K TO 4M BY 4 ECL SYNCHRONOUS SRAM (SSRAM) IN DIP, SOJ, AND TSOP–2 | Release 4 | Page 3.7.4–4 |
| 3.7.4.8 – 64K BY 4 ECL SRAM IN FP | Release 2 | Page 3.7.4–4 |
| 3.7.4.9 – 256K BY 4/512K BY 2 RECONFIGURABLE SRAM IN DIP & SOJ | Release 2 | Page 3.7.4–4 |
| 3.7.4.10 – 64K TO 4M BY 4 SRAM FAMILY IN DIP AND SOJ IN DIP, SOJ, AND TSOP–2 | Release 4 | Page 3.7.4–4 |
| 3.7.4.11 – 64K TO 4M BY 4 SSRAM FAMILY IN SIP AND SOJ IN DIP, SOJ, AND TSOP–2 | Release 4 | Page 3.7.4–4 |
| 3.7.4.12 – 64K TO 4M BY 4 SSRAM FAMILY IN SIP AND SOJ IN DIP, SOJ, AND TSOP–2 | Release 4 | Page 3.7.4–4 |
| FIGURE 3.7.4–1, 256 BY 4, 100K ECL SRAM IN DIP, 1K TO 16K BY 4, 10K & 100K ECL SRAM IN DIP | Release 1 | Page 3.7.4–5 |
| FIGURE 3.7.4–2, 256 & 1K BY 4, 100K ECL SRAM IN SFP | Release 1 | Page 3.7.4–6 |
| FIGURE 3.7.4–4, 0.25K TO 16K BY 4, 10K & 100K ECL SRAM FAMILY IN DIP | Release 1 | Page 3.7.4–7 |
| FIGURE 3.7.4–5, 16K BY 4, 10K & 100K ECL SSRAM IN DIP | Release 1 | Page 3.7.4–8 |
| FIGURE 3.7.4–6, 64K TO 4M BY 4 ECL SRAM FAMILY IN DIP, SOJ, AND TSOP–2 | Release 4 | Page 3.7.4–9 |
| FIGURE 3.7.4–7, 64K TO 4M BY 4 ECL SRAM WITH SEPARATE I/O FAMILY IN DIP, SOJ, AND TSOP–2 | Release 4 | Page 3.7.4–10 |
| FIGURE 3.7.4–8, 64K TO 4M BY 4 ECL SSRAM FAMILY IN DIP, SOJ, AND TSOP–2 | Release 4 | Page 3.7.4–11 |
| FIGURE 3.7.4–9, 64K BY 4 ECL SRAM IN FP | Release 2 | Page 3.7.4–12 |
| FIGURE 3.7.4–10, 256K BY 4 or 512K BY 2 CONFIGURABLE ECL SRAM IN DIP AND SOJ | Release 2 | Page 3.7.4–13 |
| FIGURE 3.7.4–11, 64K TO 4M BY 4 BIT SELECTABLE ECL SRAM FAMILY IN DIP, SOJ, AND TSOP–2 | Release 4 | Page 3.7.4–14 |
| FIGURE 3.7.4–12, 64K TO 4M BY 4 ECL SSRAM FAMILY IN DIP, SOJ, AND TSOP–2 | Release 4 | Page 3.7.4–15 |
| FIGURE 3.7.4–13, 64K TO 4M BY 4 BIT SELECTABLE ECL SSRAM FAMILY IN DIP, SOJ, AND TSOP–2 | Release 4 | Page 3.7.4–16 |
| **3.7.5 Byte Wide TTL SRAM** | **Release 1** | **Page 3.7.5–1** |
| 3.7.5.1 – 64 BY 9 TTL SRAM IN SCC | Release 1 | Page 3.7.5–3 |
| 3.7.5.2 – 1K & 2K BY 8 TTL SRAM IN DIP | Release 1 | Page 3.7.5–3 |
| 3.7.5.3 – 2K & 4K BY 8 TTL SRAM IN RCC | Release 1 | Page 3.7.5–3 |
| 3.7.5.4 – 2K TO 32K BY 8 TTL SRAM FAMILY IN DIP & SOJ, | Release 1 | Page 3.7.5–3 |
| 3.7.5.5 – .5K TO 32K BY 8 TTL SRAM FAMILY IN RCC | Release 1 | Page 3.7.5–3 |
| 3.7.5.6 – 32K TO 512K BY 8 TTL SRAM FAMILY IN SOJ or TSOP–2, | Release 4 | Page 3.7.5–3 |
| 3.7.5.7 – 64K TO 512K BY 8 TTL SRAM FAMILY IN DIP, | Release 1 | Page 3.7.5–3 |
| 3.7.5.8 – 32K TO 256K BY 9 TTL SRAM FAMILY IN DIP, | Release 1 | Page 3.7.5–3 |
| 3.7.5.9 – 32K TO 2M BY 8 AND 512K TO 2M BY 9 TTL SRAM IN DIP, SOJ, AND TSOP–2 | Release 4 | Page 3.7.5–3 |
| , 3.7.5.10 – 32K and 128K BY 8 TTL SSRAM IN DIP AND SOJ | Release 1 | Page 3.7.5–3 |
| , 3.7.5.11 – 2K TO 32K BY 9 DPSRAM FAMILY IN 68 SCC | Release 1 | Page 3.7.5–4 |
| 3.7.5.12 – 32K BY 9 CACHE SRAM IN 44 SCC | Release 2 | Page 3.7.5–4 |
| 3.7.5.13 – 128K BY 8 SRAM IN TSOP1 | Release 2 | Page 3.7.5–4 |
| 3.7.5.14 – 128K BY 8 & 9 SSRAM IN SOJ | Release 2 | Page 3.7.5–4 |
| 3.7.5.15 – 1K AND 2K BY 8 DPSRAM FAMILY IN 48 DIP | Release 2 | Page 3.7.5–4 |
| 3.7.5.16 – 128K TO 512K BY 8 SRAM FAMILY IN 32 CDSO–N | Release 3 | Page 3.7.5–4 |
| 3.7.5.17 – 128K TO 512K BY 8 & 9 SSRAM AND 128K BY 9 SRAM IN 33 DIP AND SOJ | Release 3 | Page 3.7.5–4 |
| 3.7.5.18 – 128K TO 2M BY 8/9 BURST SRAM IN BGA | Release 5 | Page 3.7.5–4 |
| 3.7.5.19 – 128K TO 2M BY 8/9 SSRAM IN BGA | Release 5 | Page 3.7.5–4 |
| 3.7.5.20 – 32K BY 8 SRAM IN TSOP1 | Release 7 | Page 3.7.5–4 |
| FIGURE 3.7.5–1, 64 BY 9 SRAM IN SCC | Release 1 | Page 3.7.5–5 |
| FIGURE 3.7.5–2, 1K & 2K BY 8 TTL SRAM IN DIP | Release 1 | Page 3.7.5–6 |
| FIGURE 3.7.5–3, 2K & 4K BY 8 TTL SRAM IN RCC | Release 1 | Page 3.7.5–7 |


**Release 7**



XILINX EXHIBIT 1012
Page 45

| Section | Release # | Page # |
|---|---|---|
| FIGURE 3.7.5–4, 2K TO 32K BY 8 TTL SRAM FAMILY IN DIP & SOJ | Release 1 | Page 3.7.5–8 |
| FIGURE 3.7.5–5, 0.5K TO 32K BY 8 TTL SRAM FAMILY IN RCC | Release 1 | Page 3.7.5–9 |
| FIGURE 3.7.5–6, 32K TO 512K BY 8 TTL SRAM FAMILY IN SOJ | Release 4 | Page 3.7.5–10 |
| FIGURE 3.7.5–7, 64K TO 512K BY 8 TTL SRAM FAMILY IN DIP | Release 1 | Page 3.7.5–11 |
| FIGURE 3.7.5–8, 32K TO 256K BY 9 TTL SRAM FAMILY IN DIP | Release 1 | Page 3.7.5–12 |
| FIGURE 3.7.5–9, 32K TO 2M BY 8 AND 9 TTL SRAM FAMILY IN DIP, TSOP2, AND SOJ | Release 4 | Page 3.7.5–13 |
| FIGURE 3.7.5–10, 32K AND 128K BY 8 TTL SSRAM IN DIP, TSOP2, AND SOJ | Release 4 | Page 3.7.5–14 |
| FIGURE 3.7.5–11, 2K TO 32K BY 9 DPSRAM FAMILY IN SCC | Release 1 | Page 3.7.5–15 |
| FIGURE 3.7.5–12, 32K BY 9 TTL CACHE SRAM IN SCC | Release 2 | Page 3.7.5–16 |
| FIGURE 3.7.5–13, 128K BY 8 TTL SRAM IN TSOP1 | Release 2 | Page 3.7.5–17 |
| FIGURE 3.7.5–14, 128K BY 8 & 9 TTL SSRAM IN SOJ | Release 2 | Page 3.7.5–18 |
| FIGURE 3.7.5–15A, 1K AND 2K BY 9 DPSRAM IN DIP | Release 2 | Page 3.7.5–19 |
| FIGURE 3.7.5–15B, 1K AND 2K BY 9 DPSRAM TRUTH TABLE | Release 2 | Page 3.7.5–20 |
| FIGURE 3.7.5–16, 128K TO 512K BY 8 SRAM IN CDSO–N | Release 3 | Page 3.7.5–21 |
| FIGURE 3.7.5–17, 128K AND 512K BY 8 & 9 SSRAM AND 128K BY 9 SRAM IN DIP, TSOP2, & SOJ | Release 4 | Page 3.7.5–22 |
| FIGURE 3.7.5–18 – 128K TO 2M BY 8/9 BURST SRAM IN BGA | Release 5 | Page 3.7.5–23 |
| FIGURE 3.7.5–19 – 128K TO 2M BY 8/9 SSRAM BGA IN BGA | Release 5 | Page 3.7.5–24 |
| FIGURE 3.7.5–20 – 128K TO 2M BY 8/9 SSRAM BGA BOUNDRY SCAN ORDER | Release 5 | Page 3.7.5–25 |
| FIGURE 3.7.5–21, 32K BY 8 SRAM IN TSOP2 | Release 7 | Page 3.7.5–26 |
| **3.7.6 Byte Wide ECL SRAM** | **Release 1** | **Page 3.7.6–1** |
| 3.7.6.1 – 32K and 128K BY 8 ECL SSRAM IN SOJ, SSOP, AND FP | Release 2 | Page 3.7.6–1 |
| FIGURE 3.7.6–1, 32K AND 256K BY 9 ECL SSRAM IN SOJ, SOP, AND FP | Release 2 | Page 3.7.6–3 |
| **3.7.7 Word Wide TTL SRAM** | **Release 1** | **Page 3.7.7–1** |
| 3.7.7.1 – 4K TO 64K BY 16 TTL SRAM IN DIP | Release 1 | Page 3.7.7–3 |
| 3.7.7.2 – 4K TO 256K BY 16 TTL SRAM IN SCC | Release 1 | Page 3.7.7–3 |
| 3.7.7.3 – 16K TO 256K BY 16 ADDRESS/DATA MX TTL SRAM IN DIP | Release 1 | Page 3.7.7–3 |
| 3.7.7.4 – 16K TO 256K BY 16 ADDRESS/DATA MX TTL SRAM IN RCC | Release 1 | Page 3.7.7–3 |
| 3.7.7.5 – 16K AND 64K BY 18 SRAM IN SCC | Release 1 | Page 3.7.7–3 |
| 3.7.7.6 – 64K BY 16 & 18 SRAM IN 44 SOJ | Release 3 | Page 3.7.7–3 |
| 3.7.7.7 – 32K AND 64K BY 16 & 18 SRAM AND SSRAM IN 52 SCC WITH LOGIC FEATURES | Release 4 | Page 3.7.7–3 |
| 3.7.7.8 – 64K TO 256K BY 18 SRAM & SSRAM IN TQFP | Release 5 | Page 3.7.7–4 |
| 3.7.7–9 – 64K TO 1M BY 16/18 BURST SRAM IN BGA | Release 5 | Page 3.7.7–4 |
| 3.7.7–10 – 64K TO 1M BY 16/18 SSRAM IN BGA | Release 5 | Page 3.7.7–4 |
| 3.7.7–11 – 64K TO 256K BY 16/18 BURST SRAM IN QFP/TQFP | Release 6 | Page 3.7.7–4 |
| 3.7.7–12 – 256K AND 1M BY 16/18 SRAM IN TSOP2 | Release 6 | Page 3.7.7–4 |
| FIGURE 3.7.7–1, 4K TO 64K BY 16 TTL SRAM FAMILY IN DIP | Release 1 | Page 3.7.7–5 |
| FIGURE 3.7.7–2, 4K TO 256K BY 16 TTL SRAM FAMILY IN RCC | Release 1 | Page 3.7.7–6 |
| FIGURE 3.7.7–3, 16K TO 256K BY 16 ADDRESS/DATA MX SRAM FAMILY IN DIP | Release 1 | Page 3.7.7–7 |
| FIGURE 3.7.7–4, 16K TO 256K BY 16 ADDRESS/DATA MX SRAM FAMILY IN RCC | Release 1 | Page 3.7.7–8 |
| FIGURE 3.7.7–5, 16K AND 64K BY 18 SRAM IN SCC | Release 1 | Page 3.7.7–9 |
| FIGURE 3.7.7–6, 64K BY 16 & 18 SRAM IN SOJ | Release 3 | Page 3.7.7–10 |
| FIGURE 3.7.7–7 A, 32K & 64K BY 16 & 18 SRAM AND SSRAM WITH LOGIC FEATURES IN SCC | Release 4 | Page 3.7.7–11 |
| FIGURE 3.7.7–7 B, WRITE CLOCK TIMING FOR SSRAM WITH BURST MODE | Release 4 | Page 3.7.7–12 |
| FIGURE 3.7.7–8, 64K TO 256K BY 18 SRAM AND SSRAM IN TQFP | Release 5 | Page 3.7.7–13 |
| FIGURE 3.7.7–9 – 64K TO 1M BY 16/18 BURST SRAM BGA PADOUT | Release 5 | Page 3.7.7–14 |
| FIGURE 3.7.7–10 – 64K TO 1M BY 16/18 SSRAM BGA PADOUT | Release 5 | Page 3.7.7–15 |
| FIGURE 3.7.7–11 – 64K TO 1M BY 16/18 SSRAM BGA BOUNDRY SCAN ORDER | Release 5c7 | Page 3.7.7–16 |


**Release 7**



XILINX EXHIBIT 1012
Page 46

| Section | Release # | Page # |
|---|---|---|
| FIGURE 3.7.7–12 – 64K TO 256K BY 16/18 BURST SRAM IN TQFP | Release 6 | Page 3.7.7–17 |
| FIGURE 3.7.7–10 – 256K AND 1M BY 16/18 SRAM IN TSOP2 | Release 6 | Page 3.7.7–18 |
| **3.7.8 Double Word Wide SRAM** | **Release 5** | **Page 3.7.8–1** |
| 3.7.8.1 – 32K TO 128K BY 36 SSRAM WITH BURST IN TQFP | Release 6 | Page 3.7.8–3 |
| 3.7.8.2 – 32K TO 128K BY 36 SRAM & SSRAM IN TQFP | Release 5 | Page 3.7.8–3 |
| 3.7.8.3 – 32K TO 512K BY 32/36 BURST SRAM BGA PADOUT | Release 5 | Page 3.7.8–3 |
| 3.7.8.4 – 32K TO 512K BY 32/36 SSRAM BGA PADOUT | Release 5 | Page 3.7.8–3 |
| 3.7.8.5 – 16K TO 64K BY 64 & 72 SSRAM IN QFP | Release 7 | Page 3.7.8–3 |
| FIGURE 3.7.8–1, 32K TO 128K BY 36 SSRAM WITH BURST IN TQFP | Release 6 | Page 3.7.8–5 |
| FIGURE 3.7.8–2, 32K TO 128K BY 36 SRAM AND SSRAM IN TQFP | Release 5 | Page 3.7.8–6 |
| FIGURE 3.7.7–3 – 32K TO 512K BY 32/36 BURST SRAM BGA PADOUT | Release 5 | Page 3.7.8–7 |
| FIGURE 3.7.7–4 – 32K TO 512K BY 32/36 SSRAM BGA PADOUT | Release 5 | Page 3.7.8–8 |
| FIGURE 3.7.7–5 – 32K TO 512K BY 32/36 SSRAM BGA BOUNDRY SCAN ORDER | Release 5 | Page 3.7.8–9 |
| FIGURE 3.7.8–6, 16K TO 64K BY 64 & 72 BURST SSRAM IN TQFP | Release 7 | Page 3.7.8–10 |
| **3.8 Pseudostatic Random Access Memory (PSRAM)** | **Release 1** | **Page 3.8–1** |
| **3.8.1 PSRAM, Byte Wide** | **Release 1** | **Page 3.8–3** |
| 3.8.1.1 – 2K TO 8K BY 8 PSRAM FAMILY IN DIP | Release 1 | Page 3.8–3 |
| 3.8.1.2 – 2K TO 16K BY 8 PSRAM FAMILY IN RCC | Release 1 | Page 3.8–3 |
| 3.8.1.3 – 32K TO 512K BY 8 PSRAM FAMILY IN SOJ | Release 1 | Page 3.8–3 |
| **3.8.2 PSRAM, Word Wide** | **Release 1** | **Page 3.8–3** |
| 3.8.2.1 – 4K TO 32K BY 16 PSRAM IN DIP | Release 1 | Page 3.8–3 |
| 3.8.2.2 – 4K TO 256K BY 16 PSRAM IN SCC | Release 1 | Page 3.8–3 |
| FIGURE 3.8–1, 2K TO 8K BY 8 PSRAM FAMILY IN DIP | Release 1 | Page 3.8–4 |
| FIGURE 3.8–2, 2K TO 16K BY 8 PSRAM FAMILY IN RCC | Release 1 | Page 3.8–5 |
| FIGURE 3.8–3, 32K TO 512K BY 8 PSRAM FAMILY IN SOJ | Release 1 | Page 3.8–6 |
| FIGURE 3.8–4, 4K TO 32K BY 16 PSRAM FAMILY IN DIP | Release 1 | Page 3.8–7 |
| FIGURE 3.8–5, 4K TO 256K BY 16 PSRAM FAMILY IN SCC | Release 1 | Page 3.8–8 |
| **3.9 Dynamic Random Access Memory (DRAM)** | **Release 1** | **Page 3.9–1** |
| **3.9.1 Bit Wide DRAM** | **Release 1** | **Page 3.9.1–1** |
| 3.9.1.1 – 16K BY 1 DRAM IN DIP WITH 3 SUPPLY VOLTAGES | Release 1 | Page 3.9.1–3 |
| 3.9.1.2 – 16K TO 256K BY 1 DRAM FAMILY IN DIP | Release 1 | Page 3.9.1–3 |
| 3.9.1.3 – 16K TO 256K BY 1 DRAM IN RCC | Release 1 | Page 3.9.1–3 |
| 3.9.1.4 – 64K & 256K BY 1 DRAM IN ZIP | Release 1 | Page 3.9.1–3 |
| 3.9.1.5 – 1M AND 4M BY 1 DRAM FAMILY IN DIP | Release 1 | Page 3.9.1–3 |
| 3.9.1.6 – 1M TO 16M BY 1 DRAM FAMILY IN SOJ OR TSOP2 | Release 4 | Page 3.9.1–3 |
| 3.9.1.7 – 1M TO 16M BY 1 DRAM FAMILY IN ZIP | Release 4 | Page 3.9.1–3 |
| 3.9.1.8 – 1M TO 16M BY 1 NON–MUX DRAM FAMILY IN SOJ | Release 1 | Page 3.9.1–3 |
| , 3.9.1.9 – 1M BY 1 DRAM IN TSOP1 | Release 1 | Page 3.9.1–4 |
| 3.9.1.10 – 16M BY 1/4M BY 4 CONFIGURABLE DRAM IN SOJ | Release 1 | Page 3.9.1–4 |
| 3.9.1.11 – 64M BY 1 DRAM IN SOJ OR TSOP2 | Release 5 | Page 3.9.1–4 |
| 3.9.1.12 – 2 X 16M BY 1 DRAM IN TSOP2 | Release 4 | Page 3.9.1–4 |
| FIGURE 3.9.1–1, 16K BY 1 DRAM IN DIP WITH 3 SUPPLY VOLTAGES 16K TO 256K BY 1 DRAM FAMILY IN DIP | Release 1 | Page 3.9.1–5 |
| FIGURE 3.9.1–2, 16K TO 256K BY 1 DRAM IN RCC | Release 1 | Page 3.9.1–6 |
| FIGURE 3.9.1–3, 64K & 256K BY 1 DRAM IN ZIP | Release 1 | Page 3.9.1–7 |
| FIGURE 3.9.1–4, 1M TO 64M BY 1 DRAM FAMILY IN DIP | Release 1 | Page 3.9.1–8 |
| FIGURE 3.9.1–5, 1M TO 16M BY 1 DRAM FAMILY IN SOJ and TSOP–2 | Release 4 | Page 3.9.1–9 |
| FIGURE 3.9.1–6, 1M TO 16M BY 1 DRAM FAMILY IN ZIP | Release 4 | Page 3.9.1–10 |
| FIGURE 3.9.1–7, 1M TO 16M BY 1 NON–MUX DRAM FAMILY IN SOJ | Release 2 | Page 3.9.1–11 |
| FIGURE 3.9.1–8, 1M BY 1 DRAM IN TSOP1 | Release 2 | Page 3.9.1–12 |


**Release 7**



XILINX EXHIBIT 1012
Page 47

| Section | Release # | Page # |
|---|---|---|
| FIGURE 3.9.1–9, 16M X 1/4M X 4 CONFIGURABLE DRAM IN SOJ | Release 2 | Page 3.9.1–13 |
| FIGURE 3.9.1–10, 64M BY 1 DRAM IN SOJ & TSOP2 | Release 4 a | Page 3.9.1–14 |
| FIGURE 3.9.1–11, 2 X 16M BY 1 DRAM IN TSOP2 | Release 4 | Page 3.9.1–15 |
| FIGURE 3.9.1–12, 64M BY 1 DRAM IN SOJ & TSOP2 | Release 5r7 | Page 3.9.1–16 |
| **3.9.2 Nibble Wide DRAM** | **Release 1** | **Page 3.9.2–1** |
| 3.9.2.1 – 16K & 64K BY 4 DRAM IN DIP | Release 1 | Page 3.9.2–3 |
| 3.9.2.2 – 16K BY 4 DRAM IN DIP | Release 1 | Page 3.9.2–3 |
| 3.9.2.3 – 64K BY 4 DRAM IN RCC | Release 1 | Page 3.9.2–3 |
| 3.9.2.4 – 256K & 1M BY 4 DRAM FAMILY IN DIP | Release 2 | Page 3.9.2–3 |
| 3.9.2.5 – 256K TO 4M BY 4 DRAM FAMILY IN SOJ & TSOP2 | Release 4 | Page 3.9.2–3 |
| 3.9.2.6 – 64K TO 4M BY 4 DRAM IN ZIP | Release 2 | Page 3.9.2–3 |
| 3.9.2.7 – 256K & 1M BY 4 DRAM WITH 4 CE IN SOJ & TSOP2 | Release 3 | Page 3.9.2–3 |
| 3.9.2.8 – 256K BY 4 DRAM IN TSOP1 | Release 2 | Page 3.9.2–3 |
| 3.9.2.9 – 16M BY 1/4M BY 4 CONFIGURABLE DRAM IN SOJ | Release 2 | Page 3.9.2–4 |
| 3.9.2.10 – 256K TO 4M BY 4 NON–MUX DRAM FAMILY IN SOJ | Release 2 | Page 3.9.2–4 |
| 3.9.2.11 – 4M BY 4 DRAM WITH 1 CE AND 4 CE IN TSOP2 | Release 2 | Page 3.9.2–4 |
| 3.9.2.12 – 16M BY 4 DRAM IN SOJ & TSOP2 | Release 5r7 | Page 3.9.2–4 |
| 3.9.2.13 – 1M, 2M, 4M BY 2 DRAM IN SOJ & TSOP2 | Release 3r7 | Page 3.9.2–4 |
| 3.9.2.14 – 16M BY 4 DRAM WITH 4 $\overline{CAS}$ IN SOJ & TSOP2 | Release 6 | Page 3.9.2–4 |
| 3.9.2.13 – 64M BY 4 DRAM IN TSOP2 PIN ROTATION | Release 6 | Page 3.9.2–4 |
| FIGURE 3.9.2–1, 16K & 64K BY 4 DRAM IN DIP | Release 1 | Page 3.9.2–5 |
| FIGURE 3.9.2–2, 16K & 64K BY 4 DRAM IN RCC | Release 1 | Page 3.9.2–6 |
| FIGURE 3.9.2–3, 256K & 1M BY 4 DRAM FAMILY IN DIP | Release 1 | Page 3.9.2–7 |
| FIGURE 3.9.2–4, 256K TO 4M BY 4 DRAM IN SOJ AND TSOP–2 | Release 4 | Page 3.9.2–8 |
| FIGURE 3.9.2–5, 64K TO 4M BY 4 DRAM IN ZIP | Release 1 | Page 3.9.2–9 |
| FIGURE 3.9.2–6, 256K & 1M BY 4 DRAM WITH 4 CE IN SOJ & TSOP2 | Release 6 | Page 3.9.2–10 |
| FIGURE 3.9.2–7, 256K BY 4 DRAM IN TSOP1 | Release 2 | Page 3.9.2–11 |
| FIGURE 3.9.2–8, 4M BY 4/16M BY 1 CONFIGURABLE DRAM IN SOJ | Release 2 | Page 3.9.2–12 |
| FIGURE 3.9.2–9, 256K TO 4M BY 4 NON–MUX DRAM IN SOJ | Release 2 | Page 3.9.2–13 |
| FIGURE 3.9.2–10, 4M BY 4 DRAM WITH 4 CE IN SOJ AND TSOP2 | Release 6 | Page 3.9.2–14 |
| FIGURE 3.9.2–11, 16M BY 4 DRAM IN SOJ & TSOP2 | Release 4 a | Page 3.9.2–15 |
| FIGURE 3.9.2–12, 1M, 2M, 4M BY 2 DRAM WITH 2 CE IN SOJ AND TSOP2 | Release 4r7 | Page 3.9.2–16 |
| FIGURE 3.9.2–13, 16M BY 4 DRAM IN SOJ & TSOP2 | Release 5r7 | Page 3.9.2–17 |
| FIGURE 3.9.2–14, 16M BY 4 DRAM WITH 4 $\overline{CAS}$ IN SOJ & TSOP2 | Release 6r7 | Page 3.9.2–18 |
| FIGURE 3.9.2–15, 64M BY 4 DRAM IN TSOP2 PIN ROTATION | Release 6 | Page 3.9.2–19 |
| **3.9.3 Byte Wide DRAM** | **Release 1** | **Page 3.9.3–1** |
| 3.9.3.1 – 32K BY 8 DRAM IN DIP | Release 1 | Page 3.9.3–3 |
| 3.9.3.2 – 32K BY 8 DRAM IN RCC | Release 1 | Page 3.9.3–3 |
| 3.9.3.3 – 512K BY 8 & BY 9 DRAM IN SOJ, TSOP2, & ZIP | Release 2 | Page 3.9.3–3 |
| 3.9.3.4 – 512K BY 8 & BY 9 NON–MUX DRAM IN SOJ | Release 2 | Page 3.9.3–3 |
| 3.9.3.5 – 2M BY 8 & 9 DRAM IN SOJ & TSOP2 | Release 5 | Page 3.9.3–3 |
| 3.9.3.6 – 8M BY 8 & 9 DRAM IN SOJ & TSOP2 | Release 5 | Page 3.9.3–3 |
| 3.9.3.7 – 32M BY 8 DRAM IN TSOP2 PIN ROTATION | Release 6 | Page 3.9.3–3 |
| FIGURE 3.9.3–1, 32K BY 8 DRAM IN DIP | Release 1 | Page 3.9.3–5 |
| FIGURE 3.9.3–2, 32K BY 8 DRAM IN RCC | Release 1 | Page 3.9.3–6 |
| FIGURE 3.9.3–3, 512K BY 8 & 9 DRAM IN SOJ | Release 2 | Page 3.9.3–7 |
| FIGURE 3.9.3–4, 512K BY 8 & 9 DRAM IN ZIP | Release 2 | Page 3.9.3–8 |
| FIGURE 3.9.3–5, 512K BY 8 & 9 NON–MUX DRAM IN SOJ | Release 2 | Page 3.9.3–9 |
| FIGURE 3.9.3–6, 2M BY 8 & 9 DRAM IN SOJ & TSOP2 | Release 5 | Page 3.9.3–10 |
| FIGURE 3.9.3–7, 8M BY 8 & 9 DRAM IN SOJ & TSOP2 | Release 4 a | Page 3.9.3–11 |
| FIGURE 3.9.3–8, 8M BY 8 DRAM IN SOJ & TSOP2 | Release 5r7 | Page 3.9.3–12 |

| Section | Release # | Page # |
|---|---|---|
| FIGURE 3.9.3–9, 32M BY 8 DRAM IN TSOP2 PIN ROTATION | Release 6 | Page 3.9.3–13 |
| **3.9.4 Word Wide DRAM** | **Release 1** | **Page 3.9.4–1** |
| 3.9.4.1 – 64K BY 16 DRAM WITH 2 W IN SOJ & TSOP2 | Release 1 | Page 3.9.4–3 |
| 3.9.4.2 – 256K & 1M BY 16 & 18 DRAM WITH 2 CE IN SOJ & TSOP2 | Release 5 | Page 3.9.4–3 |
| 3.9.4.3 – 256K BY 16 DRAM WITH EXTENDED FUNCTIONS IN DIP AND SOJ | Release 4 | Page 3.9.4–3 |
| 3.9.4.4 – 2M BY 16, 4M BY 16 & 18 DRAM IN TSOP2 | Release 6r7 | Page 3.9.4–3 |
| 3.9.4.5 – 128K AND 256K BY 16 BURST DRAM WITH 2 CAS IN SOJ, TSOP2, AND ZIP | Release 6 | Page 3.9.4–3 |
| 3.9.4.6 – 16M BY 16 DRAM IN TSOP2 PIN ROTATION | Release 6 | Page 3.9.4–4 |
| 3.9.4.7 – 128K ANS 256K BY 32 DRAM WITH 4 $\overline{CAS}$ IN TSOP2 | Release 6 | Page 3.9.4–4 |
| 3.9.4.8 – 512K AND 2M BY 32 & 36 DRAM WITH 4 $\overline{CAS}$ IN TSOP2 | Release 6 | Page 3.9.4–4 |
| 3.9.4.9 – 8M BY 32 DRAM IN TSOP2 PIN ROTATION | Release 6 | Page 3.9.4–4 |
| 3.9.4.10 – 2M BY 32 DRAM IN TSOP2 | Release 7 | Page 3.9.4–4 |
| FIGURE 3.9.4–1, 64K BY 16 DRAM IN SOJ | Release 1 | Page 3.9.4–5 |
| FIGURE 3.9.4–2, 256K BY 16 & 18 DRAM WITH 2 W OR 2 CE IN SOJ | Release 2 | Page 3.9.4–6 |
| FIGURE 3.9.4–3, 256K BY 16 & 18 DRAM WITH 2 W OR 2 CE IN TSOP2 | Release 4 | Page 3.9.4–7 |
| FIGURE 3.9.4–4, 1M BY 16 & 18 DRAM WITH 2 CE IN SOJ | Release 5 | Page 3.9.4–8 |
| FIGURE 3.9.4–5, 1M BY 16 & 18 DRAM WITH 2 CE IN TSOP2 | Release 5 | Page 3.9.4–9 |
| FIGURE 3.9.4–6, 64K BY 16 DRAM WITH 2 W IN TSOP–2 | Release 3 | Page 3.9.4–10 |
| FIGURE 3.9.4–7A, 256K BY 16 DRAM WITH EXTENDED FUNCTIONS IN DIP AND SOJ | Release 4 | Page 3.9.4–11 |
| FIGURE 3.9.4–7B, 256K BY 16 DRAM MANDATORY EXTENDED FUNCTION TRUTH TABLE | Release 4 | Page 3.9.4–12 |
| FIGURE 3.9.4–8, 2M BY 16, 4M BY 16 & 18 DRAM IN TSOP–2 | Release 6r7 | Page 3.9.4–13 |
| FIGURE 3.9.4–9, 128K AND 256K BY 16 BURST DRAM IN SOJ | Release 6 | Page 3.9.4–14 |
| FIGURE 3.9.4–10, 128K AND 256K BY 16 BURST DRAM IN TSOP2 | Release 6 | Page 3.9.4–15 |
| FIGURE 3.9.4–11, 128K AND 256K BY 16 BURST DRAM IN ZIP | Release 6 | Page 3.9.4–16 |
| FIGURE 3.9.4–12, 16M BY 16 DRAM IN TSOP2 PIN ROTATION | Release 6 | Page 3.9.4–17 |
| FIGURE 3.9.4–13, 128K AND 256K BY 32 DRAM WITH 4 $\overline{CAS}$ IN SSOP | Release 6 | Page 3.9.4–18 |
| FIGURE 3.9.4–14, 512K AND 2M BY 32 & 36 DRAM IN SOJ AND TSOP2 | Release 6 | Page 3.9.4–19 |
| FIGURE 3.9.4–15, 8M BY 32 DRAM IN TSOP2 PIN ROTATION | Release 6 | Page 3.9.4–20 |
| FIGURE 3.9.4–16, 2M BY 32 DRAM IN TSOP2 | Release 7 | Page 3.9.4–21 |
| **3.9.5 DRAM Optional Features** | **Release 1** | **Page 3.9.5–1** |
| 3.9.5.1 – OPTIONAL OPERATIONAL MODES AND CYCLES FOR DRAM | Release 1 | Page 3.9.5–3 |
| 3.9.5.2 – 1M DRAM BUILT IN TEST FUNCTION | Release 1 | Page 3.9.5–3 |
| 3.9.5.3 – ON–CHIP REFRESH CONTROL FOR X8 DRAM | Release 1 | Page 3.9.5–3 |
| 3.9.5.4 – G BEFORE E REFRESH | Release 1 | Page 3.9.5–3 |
| 3.9.5.5 – DRAM SPECIAL TEST AND OPERATIONAL MODES | Release 1 | Page 3.9.5–3 |
| 3.9.5.6 – NON–MULTIPLEXED DRAM OPERATION | Release 1 | Page 3.9.5–3 |
| 3.9.5.7 – DRAM EXTENDED DATA OUT DEFINITION | Release 6 | Page 3.9.5–3 |
| 3.9.5.8 – 256m DRAM TEST MODE DATA AND ADDRESS COMPRESSION | Release 7 | Page 3.9.5–3 |
| 3.9.5.9 – PIPELINED NIBBLE MODE DEFINITION | Release 7 | Page 3.9.5–3 |
| FIGURE 3.9.5–1A, DRAM ON CHIP REFRESH TIMING | Release 1 | Page 3.9.5–5 |
| FIGURE 3.9.5–1B, DRAM SELF REFRESH MODE TIMING | Release 4 | Page 3.9.5–5 |
| FIGURE 3.9.5–2, DRAM BIT WRITE TIMING | Release 1 | Page 3.9.5–6 |
| DRAM SPECIAL TEST AND OPERATIONAL MODES | Release 4 | Page 3.9.5–7 |
| OPTIONAL DRAM OPERATIONAL MODES AND CYCLES | Release 3 | Page 3.9.5–11 |
| NON–ADDRESS MULTIPLEXED DRAM OPERATIONAL REQUIREMENTS | Release 3 | Page 3.9.5–13 |
| DRAM EXTENDED DATA OUT DEFINITION | Release 6 | Page 3.9.5–14 |
| 256M DRAM ADDRESS AND DATA COMPRESSION DEFINITION | Release 7 | Page 3.9.5–15 |
| PIPELINED NIBBLE MODE DEFINITION | Release 7 | Page 3.9.5–16 |
| **3.10 Multiport Dynamic RAM (MPDRAM)** | **Release 1** | **Page 3.10–1** |


**Release 7**



XILINX EXHIBIT 1012
Page 49

| Section | Release # | Page # |
|---|---|---|
| **3.10.1 Nibble Wide MPDRAM** | **Release 1** | **Page 3.10.1–1** |
| 3.10.1.1 – 64K BY 4 MPDRAM IN DIP, SOJ, & ZIP | Release 1 | Page 3.10.1–1 |
| 3.10.1.2 – 256K BY 4 MPDRAM IN DIP, SOJ, TSOP2, & ZIP | Release 3 | Page 3.10.1–1 |
| 3.10.1.3 – 256K BY 4 TPDRAM IN SOJ | Release 2 | Page 3.10.1–1 |
| FIGURE 3.10.1–1, 64K BY 4 MPDRAM IN DIP & SOJ | Release 1 | Page 3.10.1–2 |
| FIGURE 3.10.1–2, 64K BY 4 MPDRAM IN ZIP | Release 1 | Page 3.10.1–3 |
| FIGURE 3.10.1–3, 256K BY 4 MPDRAM IN DIP, SOJ, & TSOP2 | Release 3 | Page 3.10.1–4 |
| FIGURE 3.10.1–4, 256K BY 4 MPDRAM IN ZIP | Release 1 | Page 3.10.1–5 |
| FIGURE 3.10.1–5, 256K BY 4 TPDRAM IN SOJ | Release 2 | Page 3.10.1–6 |
| **3.10.2 Byte Wide MPDRAM** | **Release 1** | **Page 3.10.2–1** |
| 3.10.2.1 – 128K AND 256K BY 8 MPDRAM IN DIP, SOJ, & TSOP2 | Release 3 | Page 3.10.2–1 |
| FIGURE 3.10.2–1, 128K AND 256K BY 8 MPDRAM IN DIP & SOJ | Release 2 | Page 3.10.2–2 |
| FIGURE 3.10.2–2, 128K BY 8 MPDRAM IN TSOP2 | Release 3 | Page 3.10.2–3 |
| **3.10.3 Word Wide MPDRAM** | **Release 1** | **Page 3.10.3–1** |
| 3.10.3.1 – 128K & 256K BY 16 MPDRAM IN SOG WITH MULTIPLE CLOCKS | Release 2 | Page 3.10.3–1 |
| 3.10.3.2 – 128K & 256K BY 16 MPDRAM IN TSOP–2 WITH MULTIPLE CLOCKS | Release 5 | Page 3.10.3–1 |
| 3.10.3.3 – 256K BY 16 SGRAM IN TSOP2 | Release 6 | Page 3.10.3–1 |
| 3.10.3.4 – 256K BY 32 SGRAM IN QFP/TQFP | Release 6 | Page 3.10.3–1 |
| 3.10.3.5 – 256K BY 32 GRAM IN TSOP–2 | Release 6 | Page 3.10.3–1 |
| 3.10.3.6 – 256K BY 32 SMPDRAM IN TSOP–2 | Release 6 | Page 3.10.3–2 |
| 3.10.3.7 – 256K BY 32 SMPDRAM IN TSOP–2 | Release 7 | Page 3.10.3–2 |
| FIGURE 3.10.3–1, 128K & 256K BY 16 MPDRAM IN SOG with 2 W & 2 CE | Release 3 | Page 3.10.3–3 |
| FIGURE 3.10.3–2, 128K & 256K BY 16 MPDRAM IN TSOP–2 with 2 W & 2 CE | Release 5 | Page 3.10.3–4 |
| FIGURE 3.10.3–3, 256K BY 16 SGRAM IN TSOP–2 | Release 6 | Page 3.10.3–5 |
| FIGURE 3.10.3–4, 256K BY 32 SGRAM IN QFP/TQFP | Release 6c7 | Page 3.10.3–6 |
| FIGURE 3.10.3–5, 256K BY 32 SGRAM IN TSOP–2 | Release 6 | Page 3.10.3–7 |
| FIGURE 3.10.3–6, 256K BY 32 SYNCH. MPDRAM IN QFP/TQFP | Release 6 | Page 3.10.3–8 |
| FIGURE 3.10.3–7, 256K BY 32 SYNCH. MPDRAM IN QFP/TQFP | Release 7 | Page 3.10.3–9 |
| **3.10.4 MPDRAM Optional Features** | **Release 1** | **Page 3.10.4–1** |
| 3.10.4.1 – 256K X 4 MPDRAM MINIMUM FEATURE SET TRUTH TABLE | Release 1 | Page 3.10.4–3 |
| 3.10.4.2 – 256K X 4 MPDRAM EXTENDED FEATURE SET TRUTH TABLE | Release 1 | Page 3.10.4–3 |
| 3.10.4.3 – MPDRAM BIT WRITE OPTIONAL FEATURE | Release 1 | Page 3.10.4–3 |
| 3.10.4.4 – 128K X 8 MPDRAM MINIMUM FEATURE SET TRUTH TABLE | Release 1 | Page 3.10.4–3 |
| 3.10.4.5 – 128K X 8 MPDRAM EXTENDED FEATURE SET TRUTH TABLE | Release 1 | Page 3.10.4–3 |
| 3.10.4.6 – 128K X 16, 256K X 8, & 256K X 16 MPDRAM MINIMUM FEATURE SET TRUTH TABLE | Release 5 | Page 3.10.4–3 |
| 3.10.4.7 – 128K X 16, 256K X 8, & 256K X 16 MPDRAM EXTENDED FEATURE SET TRUTH TABLE | Release 5 | Page 3.10.4–3 |
| 3.10.4.8 – SPLIT REGISTER WITH PROGRAMMABLE STOPS FOR MPDRAM | Release 3 | Page 3.10.4–3 |
| 3.10.4.9 – PIPELINED FAST PAGE MODE FOR MPDRAM | Release 2 | Page 3.10.4–4 |
| 3.10.4.10 – EXTENDED DATA OUT FAST PAGE MODE FOR MPDRAM | Release 2 | Page 3.10.4–4 |
| 3.10.4.11 – SAM LENGTH DEFINITION FOR 2/4M MPDRAM | Release 5 | Page 3.10.4–4 |
| 3.10.4.12 – SYNCH GRAM SPECIAL MODE SET PROCEDURE | Release 6 | Page 3.10.4–4 |
| 3.10.4.13 – SYNCH. MPDRAM SPECIAL MODE SET PROCEDURE | Release 6 | Page 3.10.4–4 |
| 3.10.4.14 – SYNCH. GRAM OPERATIONAL FUNCTION TRUTH TABLES | Release 6 | Page 3.10.4–4 |
| 3.10.4.15 – 8Mb MPDRAM FEATURE SET FUNCTION TABLE | Release 7 | Page 3.10.4–4 |
| 3.10.4.16 – EXTENDED FUNCTIONSFOR SGRAM & MPDRAM | Release 6r7 | Page 3.10.4–4 |
| TABLE 3.10.4–1, 256K X 4 MPDRAM FEATURE SET TRUTH TABLE | Release 1 | Page 3.10.4–5 |
| TABLE 3.10.4–2, 128K X 8 MPDRAM FEATURE SET TRUTH TABLE | Release 1 | Page 3.10.4–6 |
| FIGURE 3.10.4–1, BIT WRITE TIMING | Release 1 | Page 3.10.4–7 |

| Section | Release # | Page # |
|---|---|---|
| TABLE 3.10.4–3, 2Mb & 4Mb MPDRAM FEATURE SET TRUTH TABLE | Release 5 | Page 3.10.4–8 |
| FIGURE 3.10.4–2, SPLIT REGISTER WITH PROGRAMMABLE STOPS | Release 2 | Page 3.10.4–9 |
| FIGURE 3.10.4–3A, PIPELINED FAST PAGE MODE | Release 2 | Page 3.10.4–10 |
| FIGURE 3.10.4–3B, PIPELINED FAST PAGE MODE | Release 2 | Page 3.10.4–11 |
| FIGURE 3.10.4–4, MPDRAM EXTENDED DATA OUT FAST PAGE MODE | Release 4 | Page 3.10.4–12 |
| FIGURE 3.10.4–5A & 5B, SAM LENGTH DEFINITION FOR 4M MPDRAM | Release 5 | Page 3.10.4–13, 14 |
| FIGURE 3.10.4–6, SYNCH GRAM SPECIAL MODE SET PROCEDURE | Release 6 | Page 3.10.4–15 |
| FIGURE 3.10.4–7, SYNCH. MPDRAM SPECIAL MODE SET PROCEDURE | Release 6 | Page 3.10.4–16 |
| TABLE 3.10.4–4 A,B, & C , SGRAM FUNCTION TRUTH TABLE | Release 6r7 | Page 3.10.4–17⇒19 |
| TABLE 3.10.4–5, 8Mb BURST MPDRAM FUNCTION TABLE | Release 7 | Page 3.10.4–20 |
| EXTENDED FUNCTIONS FOR SGRAM & MPDRAM | Release 7 | Page 3.10.4–21 |
| **3.11 Synchronous Dynamic Random Access Memory (SDRAM)** | **Release 4** | **Page 3.11–1** |
| **3.11.1 Bit Wide SDRAM** | **Release 4** | **Page 3.11.1–1** |
| FIGURE 3.11.1–1, | Release 4 | Page 3.11.1–5 |
| **3.11.2 Nibble Wide SDRAM** | **Release 4** | **Page 3.11.2–1** |
| 3.11.2.1 – 4M BY 4 SDRAM IN TSOP2 | Release 6r7 | Page 3.11.2–1 |
| 3.11.2.2 – 16M BY 4 SDRAM IN TSOP2 | Release 6 | Page 3.11.2–1 |
| 3.11.2.3 – 64M BY 4 SDRAM IN TSOP2 PIN ROTATION | Release 7 | Page 3.11.2–1 |
| FIGURE 3.11.2–1, 4M X 4 SDRAM IN TSOP2 | Release 6r7 | Page 3.11.2–3 |
| FIGURE 3.11.2–2, 16M X 4 SDRAM IN TSOP2 | Release 6 | Page 3.11.2–4 |
| FIGURE 3.11.2–3, 64M X 4 SDRAM IN TSOP2 PIN ROTATION | Release 7 | Page 3.11.2–5 |
| **3.11.3 BYTE WIDE SDRAM** | **Release 4** | **Page 3.11.3–1** |
| 3.11.3.1 – 2M BY 8 or 9 SDRAM IN TSOP2 | Release 6r7 | Page 3.11.3–1 |
| 3.11.3.2 – 8M BY 8 SDRAM IN TSOP2 | Release 6 | Page 3.11.3–1 |
| FIGURE 3.11.3–1, 2M BY 8 OR 9 SDRAM IN TSOP2 | Release 6r7 | Page 3.11.3–3 |
| FIGURE 3.11.3–2, 8M BY 8 SDRAM IN TSOP2 | Release 6 | Page 3.11.3–4 |
| FIGURE 3.11.3–3, 32M BY 8 SDRAM IN TSOP2 PIN ROTATION | Release 7 | Page 3.11.3–5 |
| **3.11.4 WORD WIDE SDRAM** | **Release 5** | **Page 3.11.4–1** |
| 3.11.4.1 – 256K BY 16 AND 1M BY 16/18 SDRAM IN TSOP–2 | Release 6r7 | Page 3.11.4–1 |
| 3.11.4.2 – 2M & 4M BY 16 SDRAM IN TSOP–2 | Release 6r7 | Page 3.11.4–1 |
| 3.11.4.3 – 16M BY 16 SDRAM IN TSOP–2 PIN ROTATION | Release 6 | Page 3.11.4–1 |
| 3.11.4.4 – 256K BY 32 SDRAM IN QFP/TQFP | Release 6 | Page 3.11.4–1 |
| 3.11.4.5 – 2M BY 32 SDRAM IN TSOP–2 | Release 6 | Page 3.11.4–1 |
| 3.11.4.6 – 8M BY 32 SDRAM IN TSOP–2 PIN ROTATION | Release 6 | Page 3.11.4–1 |
| 3.11.4.7 – 2M BY 32 & 36 SDRAM IN TSOP–2 | Release 7 | Page 3.11.4–2 |
| FIGURE 3.11.4–1, 256 BY 16 AND 1M BY 16/18 SDRAM IN TSOP–2 | Release 6r7 | Page 3.11.4–3 |
| FIGURE 3.11.4–2, 4M BY 16 SDRAM IN TSOP–2 | Release 6r7 | Page 3.11.4–4 |
| FIGURE 3.11.4–3, 16M BY 16 SDRAM IN TSOP–2 | Release 6c7 | Page 3.11.4–5 |
| FIGURE 3.11.4–4, 256K BY 32 SDRAM IN QFP/TQFP | Release 6r7 | Page 3.11.4–6 |
| FIGURE 3.11.4–5, 2M BY 32 SDRAM IN TSOP–2 | Release 6r7 | Page 3.11.4–7 |
| FIGURE 3.11.4–6, 8M BY 32 SDRAM IN TSOP–2 PIN ROTATION | Release 6c7 | Page 3.11.4–8 |
| FIGURE 3.11.4–7, 2M BY 32 & 36 SDRAM IN TSOP–2 | Release 7 | Page 3.11.4–9 |
| **3.11.5 SDRAM Architectural and Operational Features** | **Release 4** | **Page 3.11.5–1** |
| 3.11.5.1 – SDRAM FUNCTION TRUTH TABLE | Release 5 | Page 3.11.5–3 |
| 3.11.5.2 – SDRAM FUNCTION TRUTH TABLE FOR CKE | Release 5 | Page 3.11.5–3 |
| 3.11.5.3 – SDRAM MODE REGISTER ARCHITECTURE | Release 4 | Page 3.11.5–3 |
| 3.11.5.4 → 3.11.5.15 — SDRAM OPERATIONAL CYCLES AND MODES | Release 4 | Page 3.11.5–3 |
| 3.11.5.4 – POWER ON SEQUENCE (RECOMMENDED) | Release 4 | Page 3.11.5–3 |
| 3.11.5.5 – AUTO PRECHARGE | Release 6 | Page 3.11.5–3 |
| 3.11.5.6 – PRECHARGE ALL BANKS | Release 6 | Page 3.11.5–3 |


**Release 7**

| Section | Release # | Page # |
|---|---|---|
| 3.11.5.7 – MODE REGISTER WRITE TIMING | Release 4 | Page 3.11.5–3 |
| 3.11.5.8 – AUTO REFRESH | Release 4 | Page 3.11.5–3 |
| 3.11.5.9 – WRITE LATENCY | Release 4c7 | Page 3.11.5–3 |
| 3.11.5.10 – DQM LATENCY FOR READS AND WRITES | Release 4 | Page 3.11.5–3 |
| 3.11.5.11 – PRECHARGE TIMING FOR READS | Release 4 | Page 3.11.5–3 |
| 3.11.5.12 – COLUMN ADDRESS TO COLUMN ADDRESS DELAY | Release 4 | Page 3.11.5–3 |
| 3.11.5.13 – CKE TIMING FOR POWER DOWN | Release 4 | Page 3.11.5–3 |
| 3.11.5.14 – SELF REFRESH ENTRY AND EXIT | Release 4 | Page 3.11.5–3 |
| 3.11.5.15 – CKE TIMING FOR CLOCK SUSPEND | Release 4 | Page 3.11.5–3 |
| TABLE 3.11.5–1, SDRAM FUNCTION TRUTH TABLE | Release 5 | Page 3.11.5–5 |
| TABLE 3.11.5–1, SDRAM FUNCTION TRUTH TABLE (Continued) | Release 5 | Page 3.11.5–6 |
| TABLE 3.11.5–2, SDRAM FUNCTION TRUTH TABLE for CKE | Release 5 | Page 3.11.5–7 |
| FIGURE 3.11.5–1, SDRAM MODE REGISTER ARCHITECTURE | Release 4 | Page 3.11.5–8 |
| 3.11.5.4–Power On Sequence (Recommended) | Release 4 | Page 3.11.5–9 |
| 3.11.5.5–Auto Precharge | Release 4 | Page 3.11.5–9 |
| 3.11.5.6–Precharge All Banks | Release 4c7 | Page 3.11.5–9 |
| 3.11.5.7–Mode Register Write Timing | Release 4 | Page 3.11.5–10 |
| 3.11.5.8–Auto Refresh | Release 4 | Page 3.11.5–11 |
| 3.11.5.9–Write Latency, (Write Latency = 0) | Release 4 | Page 3.11.5–12 |
| 3.11.5.10–DQM Latency for Reads and Writes, (DQM Write Latency = 0) | Release 4 | Page 3.11.5–13 |
| 3.11.5.11–Precharge Timing for Reads | Release 4 | Page 3.11.5–14 |
| 3.11.5.12–Column Address to Column Address Delay | Release 4 | Page 3.11.5–15 |
| 3.11.5.13–CKE Timing for Power Down | Release 4 | Page 3.11.5–16 |
| 3.11.5.14–Self–Refresh Entry and Exit | Release 4 | Page 3.11.5–17 |
| 3.11.5.15–CKE Timing for Clock Suspend | Release 4 | Page 3.11.5–18 |
| **4. MULTI–CHIP MEMORY MODULES & CARDS** | **Release 7** | **Page 4–1** |
| **4.1. Memory Module Nomenclature and General Features** | **Release 7** | **Page 4.1–1** |
| 4.1.1 Memory Module Nomenclature | Release 1–7 | Page 4.1–1 |
| 4.1.2 Serial Presence Detect General Standard | Release 1–7 | Page 4.1–1 |
| 4.1.2.1 SPD Appendix A | Release 7 | Page 4.1.2.1–1 |
| 4.1.2.2 SPD Appendix B | Release 7 | Page 4.1.2.2–1 |
| 4.1.2.3 SPD Appendix C | Release 7 | Page 4.1.2.3–1 |
| 4.1.2.4 SPD Appendix D | Release 7 | Page 4.1.2.4–1 |
| 4.1.2.5 SPD Appendix E | Release 7 | Page 4.1.2.5–1 |
| 4.1.2.6 SPD Appendix F | Release 7 | Page 4.1.2.6–1 |
| **4.2. One BYTE Modules** | **Release 7** | **Page 4.2–1** |
| 4.2.1 – 22 PIN SIP/SIMM 4 bit DRAM MODULE | Release 1–7 | Page 4.2–1 |
| 4.2.2 – 24 PIN SIP/SIMM 4 bit DRAM MODULE | Release 1–7 | Page 4.2–1 |
| 4.2.3 – 30 PIN SIP/SIMM 8 or 9 bit DRAM MODULE | Release 4–7 | Page 4.2–1 |
| 4.2.4 – 30 PIN SIP/SIMM 1, 2, 4, 5, or 8 bits DRAM MODULE FAMILY | Release 1–7 | Page 4.2–1 |
| 4.2.5 – 23/25/26/28 PIN ZIP/SIMM 1 or 4 bit DRAM MODULE FAMILY | Release 1–7 | Page 4.2–2 |
| 4.2.6 – 60 PIN ZIP/SIMM 4 bit SRAM MODULE | Release 1–7 | Page 4.2–2 |
| 4.2.7 – 70 PIN ZIP/SIMM 9 bit SRAM MODULE | Release 1–7 | Page 4.2–2 |
| FIGURE 4.2–1, 22, 24,& 30 PIN DRAM MODULES | Release 4–7 | Page 4.2–3 |
| FIGURE 4.2–2, 30 PIN DRAM MODULE FAMILY | Release 1–7 | Page 4.2–4 |
| FIGURE 4.2–3, 23/25/26/28 PIN DRAM MODULE FAMILY | Release 1–7 | Page 4.2–5 |
| FIGURE 4.2–4, 2 X 64K TO 1M BY 4, 60 PIN SRAM MODULE FAMILY | Release 1–7 | Page 4.2–6 |
| FIGURE 4.2–5, 64K TO 1M BY 9, 70 PIN SRAM MODULE FAMILY | Release 1–7 | Page 4.2–7 |

| Section | Release # | Page # |
|---|---|---|
| **4.3. Two BYTE Modules and Cards** | Release 7 | **Page 4.3-1** |
| 4.3.1 – 76 PIN ZIP/SIMM 9 or 18 bit SRAM MODULE | Release 1-7 | Page 4.3-1 |
| 4.3.2 – 40 PIN SIP/SIMM 1, 2, 4, 5, 8, 9, 16, or 18 DRAM MOD FAMILY | Release 1-7 | Page 4.3-1 |
| 4.3.3 – 60 PIN DRAM 16 or 18 bit CARD FAMILY | Release 2-7 | Page 4.3-1 |
| 4.3.4 – 68 PIN MULTIPLE TECHNOGY MEMORY 16 bit CARD FAMILY | Release 3-7 | Page 4.3-1 |
| FIGURE 4.3-1, 2 X 64K TO 1M BY 9, 76 PIN SRAM MODULE FAMILY | Release 1-7 | Page 4.3-3 |
| FIGURE 4.3-2, 40 PIN DRAM MODULE FAMILY | Release 1-7 | Page 4.3-4 |
| FIGURE 4.3-3A, 60 PIN DRAM CARD FAMILY PIN CONNECTIONS | Release 2-7 | Page 4.3-5 |
| FIGURE 4.3-3B, 60 PIN CARD FAMILY BLOCK DIAGRAMS | Release 2-7 | Page 4.3-6 |
| FIGURE 4.3-4A, 68 PIN MULTIPLE TECHNOLOGY CARD FAMILY | Release 3-7 | Page 4.3-7 |
| FIGURE 4.3-4B, 68 PIN MULTIPLE TECHNOLOGY CARD FAMILY FUNCTION TRUTH TABLES | Release 3-7 | Page 4.3-8 |
| **4.4. Four BYTE Modules and Cards** | Release 7 | **Page 4.4-1** |
| 4.4.1 – 64 & 72 PIN ZIP/SIMM 32 bit SRAM MODULE | Release 6-7 | Page 4.4.1-1 |
| FIGURE 4.4.1-1, 16K TO 4M BY 32, 64 & 72 PIN SRAM MODULE FAMILY | Release 6-7 | Page 4.4.1-2 |
| 4.4.2 – 72 PIN SIMM 32 or 36 bit DRAM MODULE FAMILY | Release 6-7 | Page 4.4.2-1 |
| – 72 PIN SIMM 36 or 39 DRAM ECC MODULE FAMILY | Release 6-7 | Page 4.4.2-1 |
| FIGURE 4.4.2-2, 256K TO 256M BY 36. 72 PIN DRAM MODULE FAMILY | Release 6-7 | Page 4.4.2-3 |
| FIGURE 4.4.2-2 B⇒K, 72 PIN 36 BIT DRAM SIMM BLOCK DIAGRAMS | Release 6-7 | Page 4.4.2-4⇒13 |
| FIGURE 4.4.2-3 A, 256K TO 256M BY 32, 36. & 40 BIT 72 PIN DRAM MODULE | Release 6-7 | Page 4.4.2-14 |
| FIGURE 4.4.2-3 B⇒C 72 PIN 32, 36, & 40 BIT DRAM SIMM BLOCK DIAGRAMS | Release 6-7 | Page 4.4.2-15⇒16 |
| 4.4.3 – 88 PIN, 32/36/39 bit DRAM CARD FAMILY | Release 6-7 | Page 4.4-1 |
| FIGURE 4.4.3-1 A, 256K TO 128M BY 36, 88 PIN DRAM CARD FAMILY | Release 6-7 | Page 4.4.3-3 |
| FIGURE 4.4.3-1 B, 256K TO 128M BY 36, 88 PIN DRAM CARD FAMILY CONFIGURATION TABLES | Release 6-7 | Page 4.4.3-4 |
| FIGURE 4.4.3-1 C, 256K TO 128M BY 36, 88 PIN DRAM CARD FAMILY BLOCK DIAG. | Release 6-7 | Page 4.4.3-5 |
| FIGURE 4.4.3-1 D, 256K TO 128M BY 36, 88 PIN DRAM CARD FAMILY BLOCK DIAG. | Release 6-7 | Page 4.4.3-6 |
| FIGURE 4.4.3-1 E, 256K TO 128M BY 36, 88 PIN DRAM CARD FAMILY BLOCK DIAG. | Release 6-7 | Page 4.4.3-7 |
| FIGURE 4.4.3-1 F, 256K TO 128M BY 36, 88 PIN DRAM CARD FAMILY BLOCK DIAG. | Release 6-7 | Page 4.4.3-8 |
| – 88 PIN, 40 bit DRAM CARD FAMILY | Release 4-7 | Page 4.4.3-1 |
| FIGURE 4.4.3-2 A, 256K TO 128M BY 40 DRAM CARD | Release 4-7 | Page 4.4.3-9 |
| FIGURE 4.4.3-2 B, 256K TO 128M BY 40 DRAM CARD PD TRUTH TABLE | Release 4-7 | Page 4.4.3-10 |
| FIGURE 4.4.3-2 C, 256K TO 64M BY 40 DRAM CARDUSING BY 4 DEVICES | Release 4-7 | Page 4.4.3-11 |
| FIGURE 4.4.3-2 D, 512K TO 128M BY 40 DRAM CARD USING BY 4 DEVICES | Release 4-7 | Page 4.4.3-12 |
| FIGURE 4.4.3-2 E, 512K TO 32M BY 40 DRAM CARD USING BY 8 DEVICES | Release 4-7 | Page 4.4.3-13 |
| FIGURE 4.4.3-2 F, 1M TO 64M BY 40 DRAM CARD USING BY 8 DEVICES | Release 4-7 | Page 4.4.3-14 |
| 4.4.4 – 72 PIN 32 or 36 bit DRAM SO-DIMM FAMILY | Release 5-7 | Page 4.4.4-1 |
| FIGURE 4.4.4- A 32 & 36 BIT 72 PIN DRAM SO-DIMM PINOUT, PRESENCE DETECT & CONFIGURATION TABLES | Release 6-7 | Page 4.4.4-1 |
| FIGURE 4.4.4-B-D 32 & 36 BIT DRAM SO-DIMM BLOCK DIAGRAMS | Release 5-7 | Page 4.4.4-2⇒5 |
| 4.4.5 – 88 PIN 32 or 36 bit DRAM SO-DIMM FAMILY | Release 5-7 | Page 4.4.5-1 |
| FIGURE 4.4.5-A, 88 PIN 32 & 36 BIT DRAM SO-DIMM PINOUT | Release 6-7 | Page 4.4.5-2 |
| FIGURE 4.4.5-B, 88 PIN 32 & 36 BIT DRAM SO-DIMM PD TRUTH TABLES | Release 6-7 | Page 4.4.5-3 |
| FIGURE 4.4.5-C⇒F, 88 PIN 32 & 36 BIT DRAM SO-DIMM BLOCK DIAGRAMS | Release 6-7 | Page 4.4.5-4⇒7 |
| 4.4.6 – 112 PIN 32 bits MPDRAM SO-DIMM FAMILY | Release 5-7 | Page 4.4.6-1 |
| FIGURE 4.4.6-A, 112 PIN 32 BIT MPDRAM DIMM PINOUT | Release 6-7 | Page 4.4.6-2 |
| FIGURE 4.4.6- B, C, 112 PIN 32 BIT MPDRAM DIMM PD TRUTH TABLES AND BLOCK DIAGRAMS | Release 6-7 | Page 4.4.6-3, 4 |
| 4.4.7 – 80 PIN 32 bit EEPROM SIMM FAMILY | Release 4-7 | Page 4.4.7-1 |
| FIGURE 4.4.7-A, 128K TO 8M BY 32 EEPROM SIMM, PINOUT AND PD TABLES | Release 4-7 | Page 4.4.7-3 |


**Release 7**



XILINX EXHIBIT 1012
Page 53

| Section | Release # | Page # |
|---|---|---|
| FIGURE 4.4.7–B, 128K TO 8M BY 32 EEPROM SIMM BLOCK DIAGRAM | Release 4–7 | Page 4.4.7–4 |
| 4.4.8 – 100 PIN 32, 36, or 40 BIT DRAM, SDRAM, ROM DIMM FAMILY | Release 7 | Page 4.4.8–1 |
| FIGURE 4.4.8–B & C, 32, 36, or 40 bit 100 PIN MODULE PINOUT | Release 7 | Page 4.4.8–3, 4 |
| FIGURE 4.4.8–D, 32, 36, or 40 bit 100 PIN MODULE PIN COMPARISON | Release 7 | Page 4.4.8–5 |
| FIGURE 4.4.8–E, 32, 36, or 40 bit 100 PIN MODULE CLOCK WIRING | Release 7 | Page 4.4.8–6 |
| FIGURE 4.4.8–F⇒AE, 32, 36, or 40 bit 100 PIN MODULE BLOCK DIAGRAMS | Release 7 | Page 4.4.8–7⇒32 |
| **4.5. Eight BYTE Modules and Cards** | **Release 7** | **Page 4.5–1** |
| 4.5.1 – 168 PIN Buffered DRAM, 64, 72, or 80 Bit DIMM FAMILY | Release 6–7 | Page 4.5.1–1 |
| FIGURE 4.5.1–A–B, 64, 72, or 80 BIT SIMM PINOUT, TOP & BOTTOM HALVES | Release 4–7 | Page 4.5.1–2,3 |
| FIGURE 4.5.1–C, 64, 72, or 80 BIT SIMM PRESENCE DETECT & CONFIGURATION TABLES | Release 6–7 | Page 4.5.1–4 |
| FIGURE 4.5.1–D, 64, 72, & 80 BIT DRAM SIMM Capacity Table | Release 4–7 | Page 4.5.1–5 |
| FIGURE 4.5.1–E–AB, 64, 72, & 80 BIT CONFIGURATION BLOCK DIAGRAMS | Release 4–7 | Page 4.5.1–6–29 |
| 4.5.2 – 200 PIN SDRAM, 64, 72, or 80 DIMM FAMILY | Release 5–7 | Page 4.5.2–1 |
| FIGURE 4.5.2–A, B, 8 –BYTE SDRAM DIMM PINOUT | Release 5–7 | Page 4.5.2–3,4 |
| FIGURE 4.5.2– C, 8–BYTE SDRAM DIMM PRESENCE DETECT & CONFIGURATION TABLES | Release 5–7 | Page 4.5.2–5 |
| FIGURE 4.5.2–D, E, 8–BYTE SDRAM DIMM MECHANICAL KEY AND PIN DEFINITIONS | Release 5–7 | Page 4.5.2–6 |
| FIGURE 4.5.2–F–M, 8–BYTE SDRAM DIMM BLOCK DIAGRAMS | Release 5–7 | Page 4.5.2–7,14 |
| 4.5.3 – 168 PIN Unbuffered DRAM, 64, 72, or 80 DIMM FAMILY with SPD | Release 5–7 | Page 4.5.3–1 |
| FIGURE 4.5.3–A, B, 8 –BYTE DRAM DIMM PINOUT | Release 5–7 | Page 4.5.3–2,3 |
| FIGURE 4.5.3–D, 8–BYTE DRAM DIMM MECHANICAL KEY AND PIN DEFINITIONS | Release 5–7 | Page 4.5.3–5 |
| FIGURE 4.5.3– F, 8–BYTE DRAM DIMM PRESENCE DETECT & CONFIGURATION TABLES | Release 5–7 | Page 4.5.3–7 |
| FIGURE 4.5.2–G–S, 8–BYTE DRAM DIMM BLOCK DIAGRAMS | Release 5–7 | Page 4.5.3–8,20 |
| 4.5.4 – 168 PIN Unbuffered SDRAM, 64, 72, or 80 DIMM FAMILY with SPD | Release 5–7 | Page 4.5.4–1 |
| FIGURE 4.5.4–A, B, 8 –BYTE SDRAM DIMM PINOUT | Release 5–7 | Page 4.5.4–2,3 |
| FIGURE 4.5.4– C, 8–BYTE SDRAM DIMM PRESENCE DETECT & CONFIGURATION TABLES | Release 5–7 | Page 4.5.4–4 |
| FIGURE 4.5.4–E, 8–BYTE SDRAM DIMM MECHANICAL KEY AND PIN DEFINITIONS | Release 5–7 | Page 4.5.4–6 |
| FIGURE 4.5.4–I–Y, 8–BYTE SDRAM DIMM BLOCK DIAGRAMS | Release 5–7 | Page 4.5.4–10,26 |
| 4.5.5 – 144 PIN Unbuffered DRAM, 64, or 72, SO–DIMM FAMILY with SPD | Release 5–7 | Page 4.5.5–1 |
| FIGURE 4.5.5–A, B, 8 –BYTE DRAM DIMM PINOUT | Release 5–7 | Page 4.5.5–2,3 |
| FIGURE 4.5.5–C, 8–BYTE DRAM DIMM MECHANICAL KEY AND PIN DEFINITIONS | Release 5–7 | Page 4.5.5–4 |
| FIGURE 4.5.5– E, 8–BYTE DRAM DIMM PRESENCE DETECT & CONFIGURATION TABLES | Release 5–7 | Page 4.5.5–6 |
| FIGURE 4.5.5–F–O, 8–BYTE DRAM DIMM BLOCK DIAGRAMS | Release 5–7 | Page 4.5.5–7,16 |
| 4.5.6 – 144 PIN Unbuffered SDRAM, 64, or 72 SO–DIMM FAMILY with SPD | Release 5–7 | Page 4.5.6–1 |
| FIGURE 4.5.6–A, B, 8 –BYTE DRAM DIMM PINOUT | Release 5–7 | Page 4.5.6–2,3 |
| FIGURE 4.5.6– C, 8–BYTE DRAM DIMM PRESENCE DETECT & CONFIGURATION TABLES | Release 5–7 | Page 4.5.5–6 |
| FIGURE 4.5.6–D, 8–BYTE DRAM DIMM MECHANICAL KEY AND PIN DEFINITIONS | Release 5–7 | Page 4.5.6–4 |
| FIGURE 4.5.2–G–P, 8–BYTE DRAM DIMM BLOCK DIAGRAMS | Release 5–7 | Page 4.5.6–7,17 |
| **4.6. Sixteen BYTE Modules** | **Release 7** | **Page 4.6–1** |
| 4.6.1 – 278 PIN Buffered SDRAM, 144 Bit DIMM FAMILY | Release 7 | Page 4.6.1–1 |
| FIGURE 4.6.1–A,B,C, 144 BIT SIMM PINOUT, TOP, MIDDLE, & BOTTOM PARTS | Release 7 | Page 4.6.1–2,3,4 |
| FIGURE 4.6.1–D, 144 BIT SIMM PRESENCE DETECT & CONFIGURATION TABLES | Release 7 | Page 4.6.1–5 |
| FIGURE 4.6.1–E, F, 144 BIT SDRAM DIMM MECHANICAL KEY AND PIN DEFINITIONS | Release 5–7 | Page 4.6.1–6 |
| FIGURE 4.6.1–G, H, 144 BIT SDRAM CONFIGURATION BLOCK DIAGRAMS | Release 7 | Page 4.6.1–7, 8 |
| **5 PROGRAMMABLE LOGIC AND ASIC DEVICES** | **Release 1** | **Page 5–1** |
| **5.1 Pin Out Standards** | **Release 1** | **Page 5–1** |


**Release 7**



XILINX EXHIBIT 1012
Page 54

| Section | Release # | Page # |
|---|---|---|
| **5.1.1 PIN–OUT STANDARDS FOR PLD DIP TO SCC CONVERSION** | Release 4 | Page 5–1 |
| 5.1.1.1 – 20 PIN DIP to 20 TERMINAL SCC, 0.350" BY 0.350", Fig. 5–1 | Release 1 | Page 5–1 |
| 5.1.1.2 – 24 PIN DIP to 28 TERMINAL SCC, 0.450" BY 0.450", Fig. 5–2 | Release 1 | Page 5–1 |
| 5.1.1.3 – 28 PIN DIP to 28 TERMINAL SCC, 0.450" BY 0.450", Fig. 5–2 | Release 1 | Page 5–1 |
| 5.1.1.4 – 24 PIN FUNCTIONS IN 28 PIN DIP & 28 TERMINAL SCC, Fig. 5–9 | Release 1 | Page 5–1 |
| 5.1.1.5 – 20 PIN FUNCTIONS IN 28 TERMINAL SCC AND 24 PIN DIP FOR HIGH SPEED OPERATION, Fig. 5–11 | Release 4 | Page 5–1 |
| **5.1.2 POWER PIN LOCATIONS FOR PLD and ASIC DEVICES** | Release 1 | Page 5–1 |
| 5.1.2.1 – POWER PIN LOCATIONS FOR ECL PLD IN DIP | Release 1 | Page 5–1 |
| 5.1.2.2 – POWER PIN LOCATIONS FOR TTL PLD IN DIP and CC | Release 1 | Page 5–1 |
| 5.1.2.3 – POWER PIN LOCATIONS FOR TTL PROGRAMMABLE ASIC IN DIP and CC | Release 1 | Page 5–1 |
| 5.1.2.4 – POWER PIN LOCATIONS FOR PLD IN 132 PIN QFP | Release 1 | Page 5–1 |
| **5.1.3 Nomenclature for FPLD** | Release 1 | Page 5–1 |
| **5.1.4 PLD Data Transfer Format** | Release 1 | Page 5–1 |
| **5.1.5 PLD Standard OUTPUT LOADS** | Release 5 | Page 5–1 |
| FIGURE 5–1, 20 PIN DIP TO 20 TERMINAL CC PLD CONVERSION | Release 1 | Page 5–3 |
| FIGURE 5–2, 24 & 28 PIN DIP TO 27 TERMINAL CC CONVERSION | Release 2 | Page 5–4 |
| FIGURE 5–3, POWER PIN PLACEMENT FOR ECL PLD | Release 1 | Page 5–5 |
| FIGURE 5–4, 40 PIN DIP PLD POWER PIN PLACEMENT | Release 1 | Page 5–6 |
| FIGURE 5–5, 44 TERMINAL CC POWER PIN PLACEMENT | Release 1 | Page 5–7 |
| FIGURE 5–6, 48 & 64 PIN DIP ASIC POWER PIN PLACEMENT | Release 1 | Page 5–8 |
| FIGURE 5–7, 52, 68, & 84 TERMINAL CC ASIC POWER PIN PLACEMENT | Release 1 | Page 5–9 |
| FIGURE 5–8A, PLD STANDARD LOADS, DEFINITIONS | Release5 | Page 5–11 |
| FIGURE 5–8B, PLD STANDARD LOAD CIRCUIT | Release 5 | Page 5–12 |
| FIGURE 5–8C, PLD OUTPUT LOAD CALCULATIONS | Release 5 | Page 5–13 |
| FIGURE 5–8D, PLD AC LOAD LINES | Release 5 | Page 5–14 |
| FIGURE 5–9, 24 PIN PLD FUNCTIONS IN 28 PIN DIP AND SCC | Release 3 | Page 5–15 |
| FIGURE 5–10, 132 PIN PQFP POWER PIN LOCATIONS | Release 3 | Page 5–16 |
| FIGURE 5–11, HIGH SPEED PINOUT FOR 20 PIN PLD FUNCTIONS | Release 4 | Page 5–17 |
| **6 APPLICABLE OTHER DOCUMENTS** | Release 1 | Page 6–1 |
| **6.1 – Standard Manufacturers Identification Code., JEDEC Publication No. 106A** | Release 1 | Page 6–1 |
| **6.2 – Interface Standard for Low Voltage TTL–Compatible Devices (LVTTL), JEDEC Standard No. 8 and Addendum No. 1** | Release 1 | Page 6–1 |
| **6.3 – Package Outlines, JEDEC Publication 95** | Release 1 | Page 6–1 |
| **6.4 – PLD Data Transfer Format, JEDEC Standard 3–B** | Release 1 | Page 6–1 |
| **6.5 – Nomenclature for FPLD, EIA Standard RS–428** | Release 1 | Page 6–1 |




XILINX EXHIBIT 1012
Page 55

### 2.1.17 – DC, DIAGNOSTIC CLOCK
The input that, on some devices, invokes and controls any built–in diagnostic test features.

### 2.1.18 – DQ(n)(x), DATA INPUT/OUTPUT
The pins that serve as data output(s) when in the read mode and as data input(s) when in the write mode. When the device is not selected or enabled, the output(s) are in a floating state. On a devices having both serial and parallel access ports, these pins provide access to the parallel RAM port data channels. The suffix (n) is a numeric value indicating the number assignment of a particular pin with numbering starting at 0. In some situations the letters U or L are used to indicate that the pins are assigned to the upper or lower byte of a 2 byte data interface. In devices where the standard supports an optional 9th bit that may be used as a parity bit, the suffix P may be used in lieu of a numeric value. In devices where data bit groupings have independent control, an additional suffex "x" is applied. "x" takes the values of a, b, c, etc.

### 2.1.19 – DQM, INPUT/OUPUT DATA MASK
A control signal used primarily on SDRAMs that acts as as mask for reading and writing functions. In some instances, the DQM term will includes a prefix "U" or "L" indicating upper or lower byte control. In devices where more than two data bit groupings have a data mask applied, a "x" is applied where "x" takes the values of a, b, c, etc.

### 2.1.20 – E, CHIP ENABLE
The input that, when true, permits active operation including the input and/or output of data, and when false, prevents active operation and causes the memory to be in a reduced power standby mode with the outputs floating.

### 2.1.21 – F, REFRESH
An input that, when true, causes the device to enter a data refresh mode.

### 2.1.22 – G(n), OE(n), OUTPUT ENABLE
The input that, when false, disables the outputs and causes them to go to an inactive state, but that does not effect the writing function. When disabled, the inactive state is floating (Z), for MOS and TTL devices and low (L), for ECL devices. In modules that have multiple OEs, the OEs are numbered beginning with 0.

### 2.1.23 – GS, SYNCHRONOUS OUTPUT ENABLE
An output enable input that must be set in by a synchronizing clock signal, K (q.v.).

### 2.1.24 – $\overline{I}$, INITIALIZE INPUT
A control input that provides a preassigned Manufacturer or User defined code to be set into the data register. If the input is all "0", it can be called "clear", and if all "1", then "preset".

### 2.1.25 – ID(n), IDENTIFICATION
A group of output terminals, nominally used to convey information about the configuration or other attributes of the device when plugged into a system. The function of these outputs are similar to those of the PD(n) terminals but they often have different electrical interface chatacteristics.

### 2.1.26 – I/O, INPUT/OUTPUT
A generic term for otherwise undefined signal pins which can have either an input and/or an output function. This term is not used as a specific pin name, only as a generic indicatior of the nature of the function of the pin.

### 2.1.27 – $\overline{IS}$, INITIALIZE INPUT (SYNCHRONOUS)
A control input that provides a preassigned Manufacturer or User defined code to be presented to the data register for subsequent setting by a clock input. If the input is all "0", it can be called "clear", and if all "1", then "preset".

### 2.1.28 – K, INPUT CLOCK
The input that, on devices that contain input buffer registers, causes the address on the A(n), the data on the D(n) pins and/or certain control inputs to be set into the register.

### 2.1.29 – L, LATCH ENABLE or LOWER BYTE
An input that, on devices containing a latch register, causes the data to be latched into the register. When L is used in conjunction with a data or control term it signifies that the combined term applies to the lower byte of a two byte data interface device (e.g. $\overline{LW}$).

### 2.1.30 – LB, LOWER BYTE ENABLE
An input, on wordwide devices, that, when true, enables the lower byte data input/outputs, pins DQ0 through DQ7.

### 2.1.31 – LW, LOWER BYTE WRITE ENABLE
An input, on wordwide devices, that when true causes the data present on the lower byte input/output, terminals DQ0 through DQ7, to be written into the addressed cells of the device.

### 2.1.32 – M(n), M, MODE SELECT, MASK
Input signals that when true select an alternative mode of operation for the device. The alternative modes available must be defined in the applicable device standard. When M is used in conjuction with other symbols to create a new pin name, it signifies that the pin function is either MASK or MODE related.

### 2.1.33 – MA, MATCH
An output signal that when true indicates that there has been a match (logic compare equal) between data stored in the memory and data presented on a set of input pins as defined in the individual device standard.

### 2.1.34 – MCH, MUST CONNECT HIGH
A pin which must be connected to a voltage that is interpreted as logic high or "true" signal.



XILINX EXHIBIT 1012
Page 57

**2.1.35 – MCL, MUST CONNECT LOW**
A pin which must be connected to a voltage that is interpreted as logic low or "false" signal.

**2.1.36 – NC, NO CONNECTION**
A pin to which no internal electrical connection is present or allowed.

**2.1.37 – NE, NON–VOLATILE ENABLE**
The input, on a NVRAM, that enables the non–volatile functions ST & RC as determined by the states of S,E,G, and W.

**2.1.38 – NF, NO FUNCTION**
An input that is electrically connected to the device but for which the signal has no function in the device operation.

**2.1.39 – NP, NO PIN**
A pin position on a package where the pin has been purposely been left blank or removed after assembly. No physical pin is allowed in this position.

**2.1.40 – NU, NOT USABLE**
A device pin to which there may or may not be an internal connection but to which no external connections are allowed.

**2.1.41 – OE,(n), G(n) OUTPUT ENABLE**
The input that, when false, disables the outputs and causes them to go to an inactive state, but that does not effect the writing function. When disabled, the inactive state is floating (Z), for MOS and TTL devices and low (L), for ECL devices. In modules that have multiple OEs, the OEs are numbered beginning with 0.

**2.1.42 – OP, OPTIONAL**
The designation for pins on which the manufacturer has the freedom to supply a specialized function not previously defined in the standard, and still have his part meet the requirements of the standard.

**2.1.43 – P, PROGRAM or PROGRAM ENABLE, PARITY**
The input on a non–volatile memory device that, when true, causes the data present on the D or DQ pins to be written into the addressed cell(s) of the device. The letter P may also be used as a suffix for data pins where an optional 9th bit, that may be used for parity, is allowed by the standard (e.g. DQP)

**2.1.44 – PD(n), PRESENCE DETECT**
A group of output pins, normally used on modules or cards, whose state is used to convey information about the capacity, speed, configuration, or other attributes of the device when plugged into a system.

**2.1.45 – PR, PAGE RESET**
The input on a page select memory that, when true, unconditionally causes the page select address register to be reset to zero and the corresponding page to be selected.

**2.1.46 – PS, PAGE SELECT**
The input on a page select memory that, when true, causes one of the pages of memory to be selected as identified by the inputs on the DQ pins (as defined in the appropriate function table) and for this page address to be stored in an internal register.

**2.1.47 – Q(n)(x), DATA OUTPUT**
The outputs whose state represents the data read from the selected cells. When the device is not selected or enabled, the outputs are usually in a floating (Z, high impedance) state. When the numbering of the data outputs is significant for device operation, the data outputs are numbered beginning with 0. In devices where data bit groupings have independent control, an additional suffex "x" is applied. "x" takes the values of a, b, c, etc.

**2.1.48 – RA, ROW ADDRESS INPUT**
In an address multiplexed DRAM, the address field that is captured by the ROW ENABLE signal, RAS\. When the numbering of the row address numbering is significant for device operation, the RA are numbered beginning with 0

**2.1.49 – RAS, (RE) ROW ENABLE INPUT**
A chip enable signal that, on certain dynamic RAMs, actuates only row address oriented internal circuitry. In modules that have multiple RAS\s, the RAS\s are numbered beginning with 0.

**2.1.50 – RC, RECALL**
The input on a NVRAM, that transfers the non–volatile data into the RAM array.

**2.1.51 – RFU, RESERVED FOR FUTURE USE**
A terminal whose function is not currently defined, but which is intended to be defined in some future enhancement of this Standard. This terminal should not be used (either internally or externally) until it has been further defined.

**2.1.52 – RSVD, RESERVED**
In a family of standards where some devices in the family are subsets of others, terminals that are defined in some devices but not used in others. To allow for upgradeability, the unused terminals are "RESERVED" to prevent their being used. NC has often been used in similar situations.

**2.1.53 – RY, READY**
The output that, on some devices, signifies that no internal asynchronous operations are still in process, and that the device is available for normal functions. This signal is normally implemented so that multiple devices can be OR–tied. This signal is the inverse of BY ( RY=$\overline{BY}$ )

**2.1.54 – S(n)(x), CHIP SELECT**
The input(s) that, when any one is false, causes the device to be disabled without any significant change in the power consumption. When deselected, the outputs go to the inactive state (floating (Z) for MOS and TTL devices and low (L)



XILINX EXHIBIT 1012
Page 58

for ECL devices), and the device becomes insensitive to a write command. In devices where data bit groupings have independent control, an additional suffex "x" is applied. "x" takes the values of a, b, c, etc.

**2.1.55 – ST, STORE**
The input, on a NVRAM, that initiates the non–volatile data storage of the entire RAM array.

**2.1.56 – Sxx, SYNCHRONOUS FUNCTION**
On a synchronous memory device, any input terms that are synchronous with a clock should start with the letter S. For example: $\overline{SG}$ = Synchronous Output Enable, $\overline{SW}$ = Synchronous Write Enable.

**2.1.57 – $\overline{TF}$, TEST FUNCTION**
The input, on a MEMORY that, when true, causes built in on–chip test logic to be actuated and for the part to go into its test mode of operation.

**2.1.58 – U, UPPER BYTE**
When U is used in conjunction with a data or control term it signifies that the combined term applies to the lower byte of a two byte data interface device (e.g. UW).

**2.1.59 – UB, UPPER BYTE ENABLE**
An input that, on wordwide devices, when true, enables the upper byte data input/outputs, pins DQ8 through DQ15.

**2.1.60 – UW, UPPER BYTE WRITE ENABLE**
An input, on wordwide devices, that, when true, causes the data present on the upper byte input/output, terminals DQ8 through DQ15, to be written into the addressed cells of the device.

**2.1.61 – WE, W, WRITE ENABLE**
The input that, when true, causes the data present on the D or the DQ pin(s) to be written into the address cell(s) of the device. In devices that have a WE per byte, the WEs are designated LWE & UWE for 2 byte devices. In devices that have a WE per byte and more that two bytes, the WE are numbered beginning with 0. In modules that have multiple WEs, the WEs are numbered beginning with 0.

## 2.2 MULTIPORT DRAM PIN NAMES

The following pin names apply primarily to specialized function pins for MPDRAM. In some situations, the names may also be applicable to other types of memories such as Graphics DRAMs.

**2.2.1 – DSF, SPECIAL FUNCTION ENABLE INPUT**
The input on a device, that when true, actuates certain special operational functions. In devices and modules that have multiple DSFs, the DSFs are numbered beginning with 0.

**2.2.2 – DT/$\overline{OE}$(n), $\overline{TRG}$(n), DATA TRANSFER/OUTPUT ENABLE INPUT**
The input on a device having both serial and parallel access ports that, depending on the state of one or more of the other control lines of the device, either enables an internal data transfer between the serial and parallel port circuitry, or enables the data outputs of the parallel port.

**2.2.3 – QSF, QSY, TRANSFER ACKNOWLEDGE OUTPUT**
The output on a device having both serial and parallel access ports which signifies that a transfer of data from the parallel to the serial port, in certain special transfer cycles, has been completed. In devices and modules that have multiple QSFs, the QSFs are numbered beginning with 0.

**2.2.4 – SC, SERIAL CLOCK**
An input, on devices having a serial data access port, that actuates the serial transfer of data, either in or out.

**2.2.5 – SDQ(n)(x), SERIAL DATA INPUT/OUTPUT**
The pins, on a device having a serial data access port, that serve as serial data output(s) when in the read mode and as serial data inputs(s) when in the write mode. When the device or the serial port is not selected or enabled, the output(s) are in a floating (Z) state. When the numbering of the serial data input/outputs is significant for device operation, the serial data input/outputs are numbered beginning with 0. In devices where data bit groupings have independent control, an additional suffex "x" is applied. "x" takes the values of a, b, c, etc.

**2.2.6 – SE, SERIAL PORT ENABLE**
The input that, when true, actuates the device's serial access circuitry.

**2.2.7 – SG, SERIAL PORT OUTPUT ENABLE**
The input that, when true, actuates the device's serial data output circuitry.

**2.2.8 – SQ(n), SERIAL DATA OUTPUT**
The pins, on a device having a serial data access port, that serve as serial data output(s) when in the read mode, When the device or the serial port is not selected or enabled, the output(s) are in a floating (Z) state. When the numbering of the serial data outputs is significant for device operation, the serial data outputs are numbered beginning with 0.

**2.2.9 – $\overline{TRG}$(n), DT/$\overline{OE}$(n) DATA TRANSFER/OUTPUT ENABLE INPUT**
The input on a device having both serial and parallel access ports that, depending on the state of one or more of the other control lines of the device, either enables an internal data transfer between the serial and parallel port circuitry, or enables the data outputs of the parallel port.

## 2.3 POWER PIN NAMES

The following symbols are used to designate the power pins in a memory device. When only a single pin is provided for a given supply, the pin name is used without suffix. When multiple pins are used, a suffix may be used to designate specific pins. A numeric suffix is used to indicate the preferred order of implementation when optional redundant pins are allowed. An alphabetic suffix is used to indicate pins which have a specific power circuit or loop connection. The use of a common suffix for different supplies indicates that those pins connect to a common power loop.

### 2.3.1 – VBB, SUBSTRATE POWER VOLTAGE

A bias voltage that maintains the substrate at a potential which is negative with respect to GND or VSS in an NMOS or CMOS part.

### 2.3.2 – VCC, LOGIC POWER VOLTAGE

The most positive potential of the two logic power supply pins. This is used for the memory device power voltage when the supply voltage is nominally 5 V. VCC is also commonly used to designate the ground reference power supply voltage for ECL interface devices.

### 2.3.3 – VCCQ, OUTPUT STAGE LOGIC POWER VOLTAGE

See VDDQ for definition. VCCQ is restricted to 5 V applications only

### 2.3.4 – VDD, DRAIN POWER VOLTAGE

The primary power voltage on MOS devices that require a potential that is different from the normal system logic voltage. This is used interchangeably with VCC on devices that use 5 V.

### 2.3.5 – VDDQ, OUTPUT STAGE DRAIN POWER VOLTAGE

The power pin that is intended to feed power to the output transistors of the device to supply the potential and energy to drive the load applied to the data output (Q) pins or data input/output (DQ) pins. Other, non–data, output pin transistors may also be designated to be fed by this power pin. VDDQ/VCCQ may be specified to have the same or a different potential from that feeding the primary device power pins (VDD/VCC) but is DC isolated on the chip from these and any other chip power pins.

### 2.3.6 – VEE, EMITTER POWER VOLTAGE

For ECL interface devices, the primary and most negative power supply terminal.

### 2.3.7 – VHH, SPECIAL FUNCTION ENABLE VOLTAGE

A special high voltage logic level (super voltage) that enables special on–chip functions.

### 2.3.8 – VPP, PROGRAMMING POWER VOLTAGE

A special high voltage supply that supplies the potential and energy for altering the state of certain non–volatile memory arrays. On some devices the presence of VPP also acts as a PROGRAM ENABLE signal (see P).

### 2.3.9 – VREF, REFERENCE POWER SUPPLY

A power supply that acts as a reference for determining internal threshold voltages but does not supply any substantial power to the device.

### 2.3.10 – VSS, (GND), GROUND REFERENCE or SOURCE POWER VOLTAGE

The ground reference voltage for NMOS, CMOS, and TTL devices, commonly the reference pin for all other device pins. VSS is normally the system ground and the symbol is often used interchangeably with GND.

### 2.3.11 – VSSQ, (GNDQ), OUTPUT STAGE SOURCE POWER VOLTAGE or OUTPUT STAGE GROUND REFERENCE

The ground reference voltage for the data output (Q) or input/output (DQ) pins. Other, non–data, output pin transistors may also be designated to be referenced to this ground pin. Internal to the device, this pin shall be DC isolated from the primary ground reference (VSS) pin and any other ground reference pin. External to the device it must be DC common with the primary ground reference.

## 2.4 DEVICE TYPE NAMES

### 2.4.1 – ASIC, Programmable Application Specific Device
A complex array of logic elements whocs interconnection pattern can be field programmed to fill the needs of specific applications.

### 2.4.2 – BDRAM, Burst DRAM
A DRAM that has BURST mode data capability.

### 2.4.3 – Bxxx,
Device names that have the prefix "B" are devices that have a "Burst" data capability.

### 2.4.4 – DPM, Dual Port Memory
Any memory that has two essentially identical data ports.

### 2.4.5 – DPSRAM, Dual Port Static RAM
A static RAM that contains two sets of identical random access address and data ports.

### 2.4.6 – DRAM, Dynamic Random Access Memory
These devices are made using Dynamic RAM circuit configurations that have data storage that must be refreshed periodically.

### 2.4.7 – FEEPROM, Flash EEPROM
An EEPROM in which clearing can be performed only on blocks or the entire array.
Note: there are no restrictions on the block archetecture in the fefinition of FEEPROM. the blocks within a device may be of various capacities ranging from a single address to the entire memory array.

### 2.4.8 – EEPROM, Electrically Erasable Programmable Read Only Memory
A reprogammable ROM in which cells may be erased electrically and in which each cell may be reprogrammed electrically.

### 2.4.9 – EPROM, Erasable Programmable Read Only Memory
A reprogrammable ROM in which all cells may be simultaneously erased using ultraviolet light and in which each cell may be reprogrammed electrically.

### 2.4.10 – GRAM, Gaphics DRAM
A DRAM that contains special graphics features, similar to those contained in a MPDRAM. When the term has a prefix "S", it becomes synchronous GRAM.

### 2.4.11 – LPROM, Latched PROM
A PROM that contains a latch register for the output data.

### 2.4.12 – MPDRAM, Multiport DRAM
A dynamic RAM that contains in addition to the conventional random access data and address port, a serial access port that allows serial access to a portion of the stored data in a way which is independent of the normal RAM data terminals and in which simultaneous serial and random operations may be executed. This type of memory has been referred to as "Video RAM" because of its primary field of application.

### 2.4.13 – MPM, Multiport Memory
Any memory array that has two or more data ports which do not have the same architecture. The most common form of MPM is one in which there is a random access port and a serial access port.

### 2.4.14 – MPRAM, Multiport RAM
A RAM that has more than one port for data, address, and control, that are not identical in nature. Normally at least one port provides parallel access while one other provides serial access. When the term has a prefix "S", it becomes s synchronous MPDRAM.

### 2.4.15 – NVRAM, Non–Volatile Random–Access Memory
An SRAM in which provisions exist on chip for the state of the cells to be saved when power is removed.

### 2.4.16 – PLD, Programmable Logic Array
An array of logic elements in which the interconnection pattern can be programmed (either mask or user programmed) to perform specific logic functions.

### 2.4.17 – PROM, Programmable Read–Only Memory
A field programmable ROM which can have the data content of each cell altered only once.

### 2.4.18 – PSRAM, Pseudo Static Random–Access Memory
A combinational form of dynamic RAM that incorporates various refresh and control circuits on–chip (e.g. refresh address counter and multiplexer, interval timer, and/or arbiter). These circuits allow the PSRAM operating characteristics to closely resemble those of a SRAM.

### 2.4.19 – RAM, Random–Access Memory
A memory in which access to all storage data can be achieved in essentially the same time, independent of the location. In a multiport memory, this term refers to that portion of the array which contains the memory cell array and its drivers, sense amplifiers, and control circuitry and the circuitry associated with the normal random access data port.

### 2.4.20 – ROM, Read–Only Memory
A memory in which the contents are not intended to be altered during operation.

### 2.4.21 – RPROM, Registered PROM
A PROM that contains a "D" type FF register for the output data.



XILINX EXHIBIT 1012
Page 61

**2.4.21 – Sxxx**
The prefix "S" on a device term can mean either "Static" as in SRAM, "Serial" as in SAM, or "Synchronous" as in SDRAM and SGRAM.

**2.4.22 – SAM, Serial Access Memory**
A memory (or serial port in a multiport memory) in which data is accessed sequentially and the time for access depends on the location of the data desired. In a multiport memory, this term refers to that portion of the device which is related to the serial access port and its associated functions.

**2.4.23 – SDRAM, Synchronous DRAM**
A DRAM that has a clocked synchronous interface.

**2.4.24 – SGRAM, Synchronous Graphics DRAM**
A GRAM that has a synchronous interface.

**2.4.25 – SMPDRAM, SVRAM, Synchronous MPDRAM (VRAM)**
An MPDRAM that has a synchronous interface on all ports.

**2.4.26 – SRAM, Static Random Access Memory**
A read/write memory in which the data is retained in the absence of control signals generated inside or outside the integrated circuit.

**2.4.27 – SSRAM, Synchronous Static RAM**
An SRAM that has input and/or output buffers (either register or latch), that are controlled by an externally supplied clock (or clocks).

**2.4.28 – VRAM, Video Ram**
A term commonly used in the Industry to describe the device class referred to in this standard as MPDRAM. It is a multi–ported DRAM that has features keyed to the video buffer application



XILINX EXHIBIT 1012
Page 62

## 2.5 MISCELLANEOUS DEVICE RELATED TERMS

**2.5.1 – Bit Plane**
In a semiconductor memory device having a data interface that is wider than 1 bit, those storage cells and associated circuitry which are associated with a given bit in the data interface.

**2.5.2 – Bit Wide**
A class of memory devices that have only a single–bit data interface.

**2.5.3 – Byte Wide**
A class of memory devices that have a parallel 8–bit or occasionally 9–bit data interface.

**2.5.4 – K**
When describing the storage capacity of a memory device the quantity K=1024 is used.

**2.5.5 – M**
When describing the storage capacity of a memory device, the quantity M=2 exp 20 or 1024 K is used.

**2.5.6 – MX, Multiplexed**
A term describing a device that has pins used for different purposes at different times as a function of one or more of its control inputs. The signal groups that are multiplexed onto a common pin set are given together as in: AA MX signifying ADDRESS, ADDRESS multiplex, OR ADQ MX signifying ADDRESS, DATA IN, DATA OUT multiplex.

**2.5.7 – Nibble Wide**
A class of memory devices that have a parallel 4–bit data interface. This term should not be confused with "nibble mode" (see 3.1.3.2), which refers to a serial data access mode in memories.

**2.5.8 – Word Wide**
A class of memory devices that have a parallel 16–bit or longer data interface.



XILINX EXHIBIT 1012
Page 63

## 2.6 Special Operational Cycles for MPDRAM

The following terms describe a series of special operational cycles for MPDRAM. They are presented in the order of their logical relationships rather than alphabetically.

### 2.6.1 LOGIC SETUP, (LS)

A special non-memory cycle in which the logic state of the device is set up to actuate the desired mode of operation for future memory cycles. The selected mode is normally persistent until canceled by some subsequent special control cycle.

### 2.6.2 INTERNAL REFRESH, (CBR)

Defined in 3.9.2.3.

### 2.6.3 WRITE TRANSFER, (WT)

An operation in which the data to be written is introduced through the serial port and is then transferred internally to the memory array data bus for writing into the cells. At the same time the "Tap Pointer" is set. This is a counter that defines the starting point in the serial register into which data is entered. Data is entered serially from this point with wrap around when the end of the register is reached. The contents of the full serial register are transferred in parallel. In addition to the normal write transfer, there are numerous other types of special write transfers defined in the following paragraphs.

### 2.6.4 PSEUDO WRITE TRANSFER, (PWT)

This is a non-memory cycle in which the operational mode of the serial port is changed from output to input. At the same time the "Tap Pointer" is set. This is a counter that defines the starting point in the serial data register into which data is entered. Data is entered serially from this point with wrap around when the end is reached.

### 2.6.5 MASKED WRITE TRANSFER, (MWT)

A write transfer in which the transfer of new data from the serial register into the memory array is controlled by a "Write Mask" that is supplied on the DQ(n) terminals. This mask allows the selective writing of new data into one or more of the data bit planes of the storage array corresponding to the data bits of the parallel array. In a normal implementation, a high M value enables the writing of new data while a low M inhibits the writing and leaves the existing data unchanged. A new mask value must be supplied for each masked write cycle.

### 2.6.6 FLASH WRITE WITH MASK, (FWM)

A write cycle in which the contents of an entire row of the memory array can be selectively set to a stated value. The "mask" value determines which bit planes are to be altered while the "color register" (qv) contains the data value to be written. The color register is loaded in a previous "Load Color Register" cycle with a persistent value. The mask value is supplied during the cycle on the DQ(n) terminals. A new mask value must be supplied for each cycle performed. A high mask bit normally enables the write function for that bit. A low mask bit leaves the data unaltered.

### 2.6.7 SPECIAL WRITE TRANSFER

A write transfer in a device that has variations in the architecture of the SAM data register to allow improved performance in the internal SAM to RAM data transfers. These variations are defined in the following paragraphs.

### 2.6.8 SPLIT WRITE TRANSFER, (SWT)

A write transfer in which the SAM data register is split into two halves and the data is transferred to the RAM data bus separately after each half of the SAM register is filled.

### 2.6.9 AUTO-LOAD WRITE TRANSFER, (AWT)

A split SAM data register transfer in which the transfer from each half is automatically triggered by the state of the tap pointer counter after each half of the SAM register is filled.

### 2.6.10 READ TRANSFER, (RT)

A read operation in which the contents of one row of the memory array is transferred into the SAM data register in parallel.

### 2.6.11 SPECIAL READ TRANSFER

A read transfer in a device that has variations in the architecture of the SAM data register to allow improved performance in the internal RAM to SAM data transfers. These variations are defined in the following paragraphs.

### 2.6.12 SPLIT READ TRANSFER, (SRT)

A read transfer in which the SAM data register is split into two halves and the data is transferred from the RAM data bus separately into each half of the SAM register as it is needed for transfer to the SDQn terminals.

### 2.6.13 AUTO-LOAD READ TRANSFER, (ART)

A split SAM data register transfer in which the transfer into each half is automatically triggered by the state of the tap pointer counter after each half of the SAM register is emptied.



XILINX EXHIBIT 1012
Page 64

### 3.5.1.10 - 32K TO 256K BY 8 EEPROM FAMILY IN TSOP1

CAPACITY--32K, 64K, 128K, & 256K WORDS OF 8 BITS,
PACKAGE--32 LEAD TSOP-1, 8 mm X 18.4 mm
PIN ASSIGNMENT--Fig. 3.5.1-10

### 3.5.1.11 - EXTENDED FEATURE SET FOR 256K BIT EEPROM

This standard specifies features beyond the existing pinout standards that need to be standardized for 32K X 8 EEPROMs to achieve operational compatibility. A summary of the required and optional features is listed below. The full standard follows the pinout drawings at the end of Sec. 3.5.1..

### 3.5.1.11.1 - REQUIRED STANDARD FEATURES

The following features are the minimum set necessary to achieve functional compatibility for 32K Byte EEPROMs and must be implemented to be in compliance with this standard:
-Operate with a primary power supply of 5.0 V nominal
-Operate in conformance with the standard truth table
-Have read and write timing cycles which are consistent with the standard timing diagrams
-Contain Data & Address Latches for Write cycles
-Operate with self timed write cycles
-Operate with input levels between 0 and 5 Volts.

### 3.5.1.11.2 - OPTIONAL FEATURES

The following features are optional and are not required for the part to conform to this standard. If any of these features are implemented, they must operate as defined in order to maintain compatibility and to be in compliance with this standard:
-Page Write Mode with standard write cycle timings
-Minimum page size of 16 Byte in page write mode
-DATA\ Polling
-Software Data Protect Option
-Hardware Mass Erase (All 1's)
-Software Mass Erase (All 1's)

### 3.5.1.12 - OPTIONAL COMMAND SET FOR DUAL-SUPPLY EEPROM

This Standard provides an optional command set for DUAL-SUPPLY EEPROM devices (commonly known as FLASH EEPROM). This set includes the existing algorithmic commands and adds a series of automatic codes. A component may respond to either or both of the operating modes. The COMMAND SET TRUTH TABLE is shown in Figure 3.5.2-4

### 3.5.1.13 - 512K BY 8 DUAL-SUPPLY EEPROM IN RCC

CAPACITY--512K WORDS OF 8 BITS,
PACKAGE--32 LEAD RCC, 11.43 mm X 13.97 mm (0.450" X 0.550")
PIN ASSIGNMENT--Fig. 3.5.1-12

### 3.5.1.14 - 128K TO 512K BY 8 SINGLE-SUPPLY EEPROM FAMILY IN DIP, RCC, & TSOP-1

CAPACITY--32K, 64K, 128K, & 256K WORDS OF 8 BITS,
THESE DEVICES ARE APPROVED IN THREE PACKAGES:
DIP PACKAGE--32 LEAD DIP, 15.24 mm (0.6") WIDE WITH 2.54 mm (0.1") PP
PIN ASSIGNMENT--Fig. 3.5.1-13
RCC PACKAGE--32 LEAD RCC, 11.43 mm X 13.97 mm (0.450" X 0.550")
PIN ASSIGNMENT--Fig. 3.5.1-14
TSOP-1 PACKAGE--32 LEAD TSOP-1, 8 mm X 20 mm WITH 0.5 mm PP
PIN ASSIGNMENT--Fig. 3.5.1-15

### 3.5.1.15 – 256K, 512K, & 1M BY 8 DUAL–SUPPLY EEPROM IN TSOP–1

CAPACITY—256K, 512K, 1M WORDS OF 8 BITS,
PACKAGE—40 LEAD TSOP–1, 10 mm X 20 mm WITH 0.5 mm PP
PIN ASSIGNMENT—256K, 512K, Fig. 3.5.1–18
PIN ASSIGNMENT—1M, Fig. 3.5.1–16

The 256K & 512K devices have a different pin assignment pattern from the 1M device, therefor are not backward compatible with the 1M device.

### 3.5.1.16 – 1M TO 8M BY 8 SINGLE–SUPPLY EEPROM FAMILY IN TSOP–1

CAPACITY—1M, 2M, 4M, & 8M WORDS OF 8 BITS,
PACKAGE—48 LEAD TSOP1, 12 mm X 20 mm WITH 0.5 mm PP
PIN ASSIGNMENT—Fig. 3.5.1–17

### 3.5.1.17 – 8K BY 256B OR 264B SERIAL ACCESS EEPROM IN TSOP–2

CAPACITY—8K WORDS OF 256 OR 264 BYTES, SERIALLY ACCESSED
PACKAGE—44/40 LEAD TSOP2, 10.16 mm WIDE WITH 0.8 mm PP
PIN ASSIGNMENT—Fig. 3.5.1–19 A
CONTROL & LOGIC TABLES—Figs. 3.5.1–19 B & C

### 3.5.1.18 – 1M & 2M BY 8 SINGLE OR DUAL SUPPLY EEPROM FAMILY IN PSOP

CAPACITY—1M & 2M WORDS OF 8 BITS,
PACKAGE—44 LEAD PSOP 16 mm wide WITH 1.27 mm PP
PIN ASSIGNMENT—Fig. 3.5.1–20



XILINX EXHIBIT 1012
Page 66

## Logic Table

| Function | CL | AL | $\overline{E}$ | $\overline{W}$ | $\overline{R}$ | $\overline{WP}$ |
|---|---|---|---|---|---|---|
| Command Input | H | L | L | ⌐‾⌐ | H | · |
| Data Input | L | L | L | ⌐‾⌐ | H | · |
| Address Input | L | H | L | ⌐‾⌐ | H | · |
| Address Output | L | H | L | H | ⌐‾⌐ | · |
| Serial Read & Output | L | L | L | H | ⌐‾⌐ | · |
| During Auto Program | · | · | · | · | · | H |
| During Auto Erase | · | · | · | · | · | H |
| During Busy State | · | · | · | · | · | H |
| Program/Erase Protect | · | · | · | · | · | L |

## Serial Address Input

| | ADQ0 | ADQ1 | ADQ2 | ADQ3 | ADQ4 | ADQ5 | ADQ6 | ADQ7 |
|---|---|---|---|---|---|---|---|---|
| 1st Cycle | A0 | A1 | A2 | A3 | A4 | A5 | A6 | A7 |
| 2nd Cycle | A8 | A9 | A10 | A11 | A12 | A13 | A14 | A15 |
| 3rd Cycle | A16 | A17 | A18 | A19 | A20 | RFU | RFU | RFU |

A0 ⇒ A7 : Column Address
A8 ⇒ A11 : NAND Address
A12 ⇒ A20 : Block Address

## PIN DEFINITIONS

The following pin terms are used in this device, but some may not appear in Sec. 2 on terminology of this Standard,

CL: Command Latch Enable
$\overline{E}$: Chip Enable
$\overline{R}$: Read Enable
RY: Ready
AL: Address Latch Enable
$\overline{W}$: Write Enable
$\overline{WP}$: Write Protect
ADQn: Address/Data/Command Multiplex

## FIGURE 3.5.1–19 C
## 8K BY 256B or 8K BY 264B SERIAL ACCESS EEPROM LOGIC TABLE

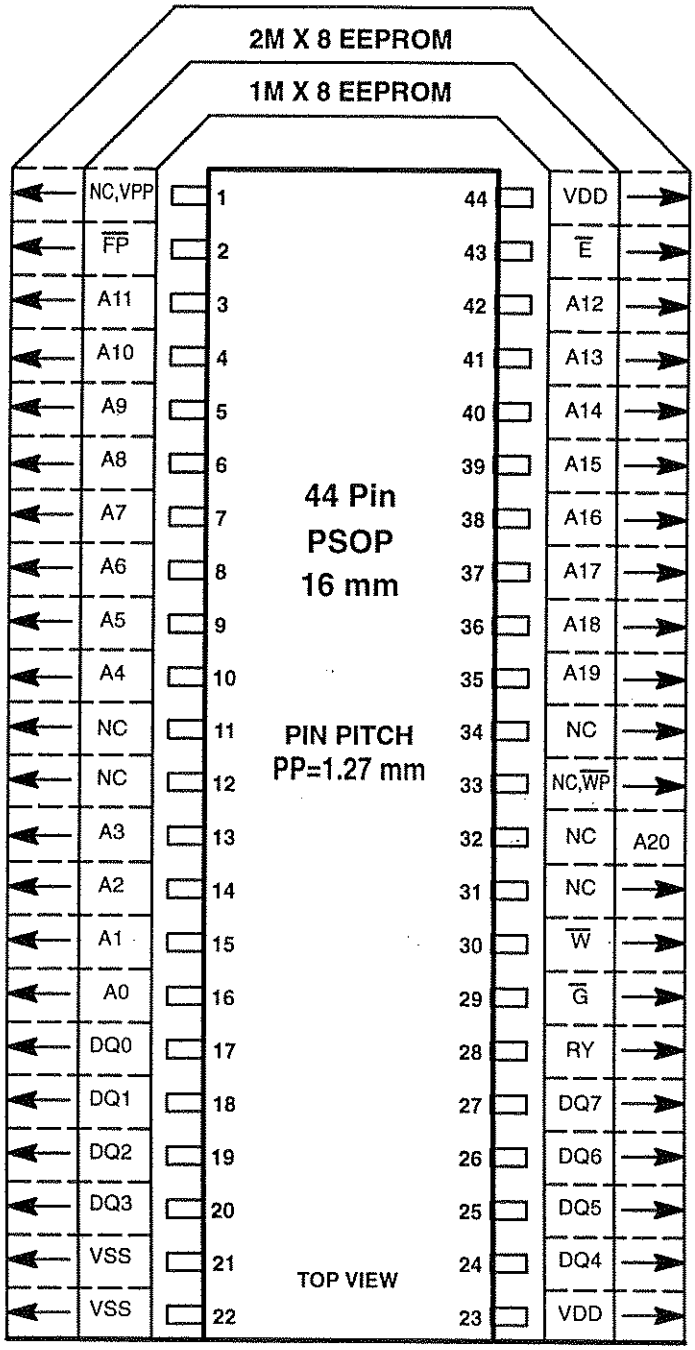



**FIGURE FIGURE 3.5.1–20**
**1M & 2M BY 8 SINGLE OR DUAL SUPPLY EEPROM IN PSOP**

**Release 7**

### 3.5.2.1 – 4K TO 32K BY 16 EEPROM IN DIP

CAPACITY—4K TO 32K WORDS OF 16 BITS,
PACKAGE—40 PIN DIP, 0.6" WIDE
PIN ASSIGNMENTS—Fig. 3.5.2–1

### 3.5.2.2 – 4K TO 256K BY 16 EEPROM IN SCC

CAPACITY—4K TO 256K WORDS OF 16 BITS,
PACKAGE—44 PAD (PIN) RCC, 0.650" X 0.650"
PIN ASSIGNMENTS—Fig. 3.5.2–2

### 3.5.2.3 – 256K TO 128M BY 16 EEPROM IN DIP AND SOP

CAPACITY—256K, 512K, 1M, 2M, 4M, 8M, 16M, 32M, 64M, and 128M WORDS OF 16 BITS
PACKAGE—44, 48 or 52 PIN DIP and SOP, 0.600" WIDE
PIN ASSIGNMENTS—256K TO 2M, Fig. 3.5.2–4
PIN ASSIGNMENTS—4M TO 128M, Fig. 3.5.2–3

### 3.5.2.4 – 1M TO 4M BY 16 DUAL SUPPLY EEPROM IN SSOP

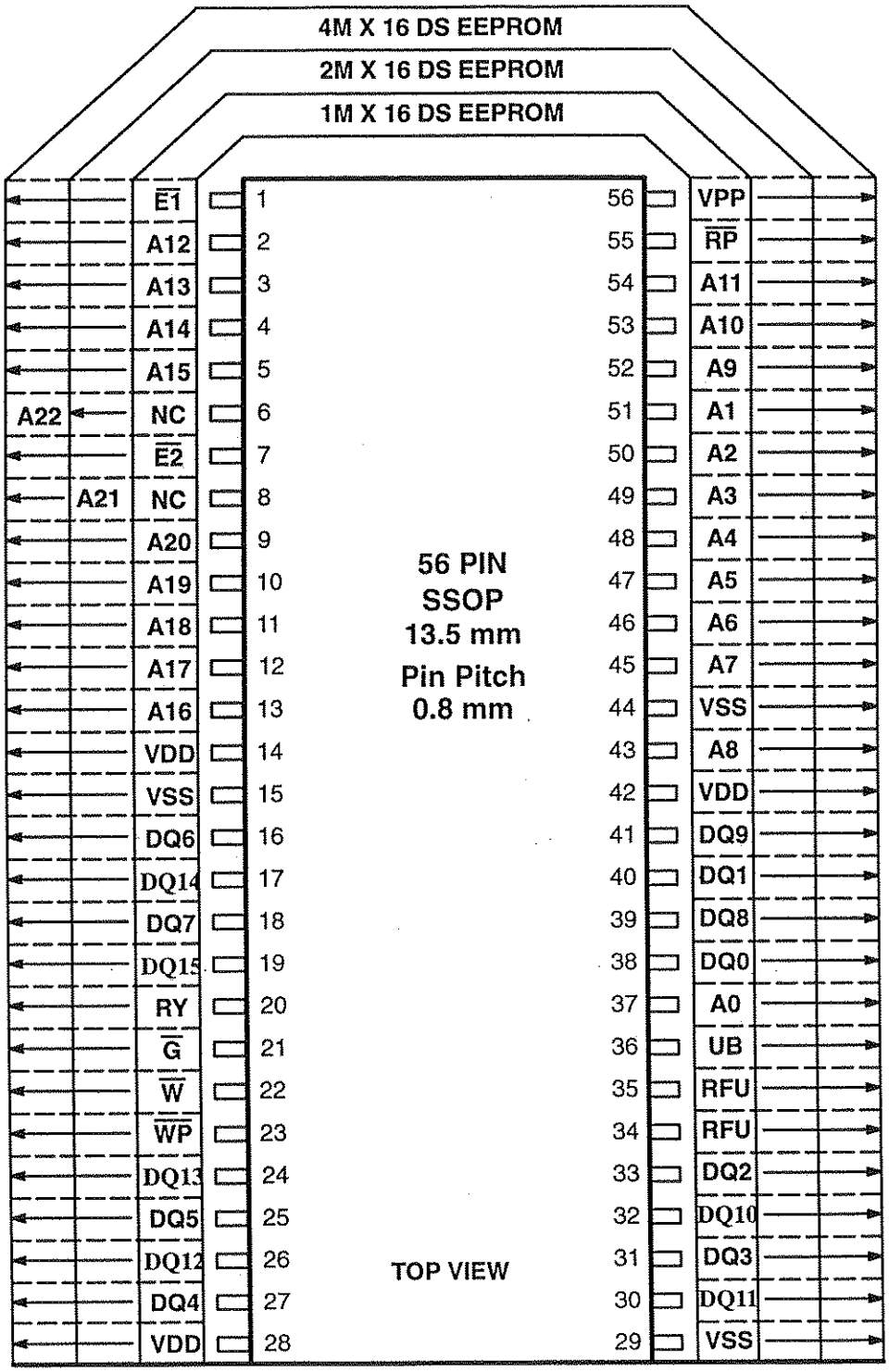
CAPACITY—1M, 2M, 4M WORDS OF 16 BITS,
PACKAGE—56PIN SSOP, 13.5 mm WIDE, 0.8 mm PIN PITCH
PIN ASSIGNMENTS—Fig. 3.5.2–5

### 3.5.2.5 – 1M, 2M, & 4M DENSITY, BY 8 & 16 FEEPROM IN PSOP

CAPACITY—1M, 2M, & 4M, BITS WITH x8 OR x16 DATA INTERFACE.
—128K, 256K, OR 512K WORDS OF 8 BITS
—64K, 128, OR 256K WORDS OF 16 BITS
PACKAGE—44 PIN PSOP, 16 mm WIDE
PIN ASSIGNMENTS—Fig. 3.5.2–6
POWER SUPPLIES—SINGLE OR DUAL SUPPLY DESIGN

### 3.5.2.6 – 1M TO 32M DENSITY, BY 8 & 16 FEEPROM IN TSOP1

CAPACITY—1M, 2M, 4M, 8M, 16M, & 32M BITS WITH x8 OR x16 DATA INTERFACE.
—128K, 256K, 512K, 1M, 2M, OR 4M WORDS OF 8 BITS
—64K, 128, 256K, 512K, 1M, OR 2M WORDS OF 16 BITS
PACKAGE—44 PIN TSOP1, 20 mm X 16 mm with 0.5 mm PP.
PIN ASSIGNMENTS—Fig. 3.5.2–7
POWER SUPPLIES—SINGLE OR DUAL SUPPLY DESIGN




| | UB | A0 | DQ0 ⇒DQ7 | DQ8⇒DQ15 |
|---|---|---|---|---|
| Word Access | VIH | X | Even Byte | Odd Byte |
| Odd Byte Access | VIL | VIH | Odd Byte | High Z |
| Even Byte Access | VIL | VIL | Even Byte | High Z |

**FIGURE 3.5.2–5**
**1M TO 4M BY 16 DUAL SUPPLY EEPROM IN SOP**

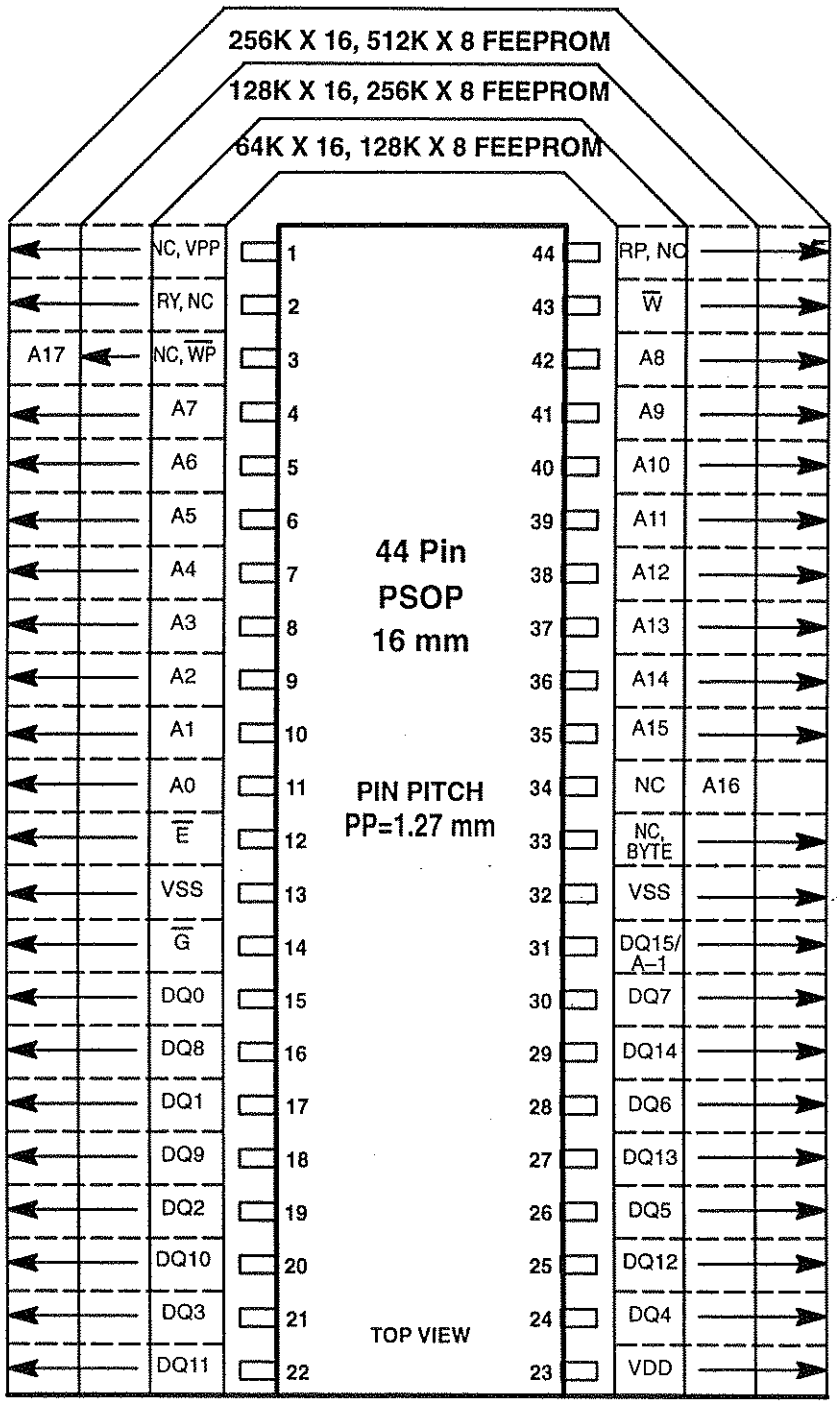
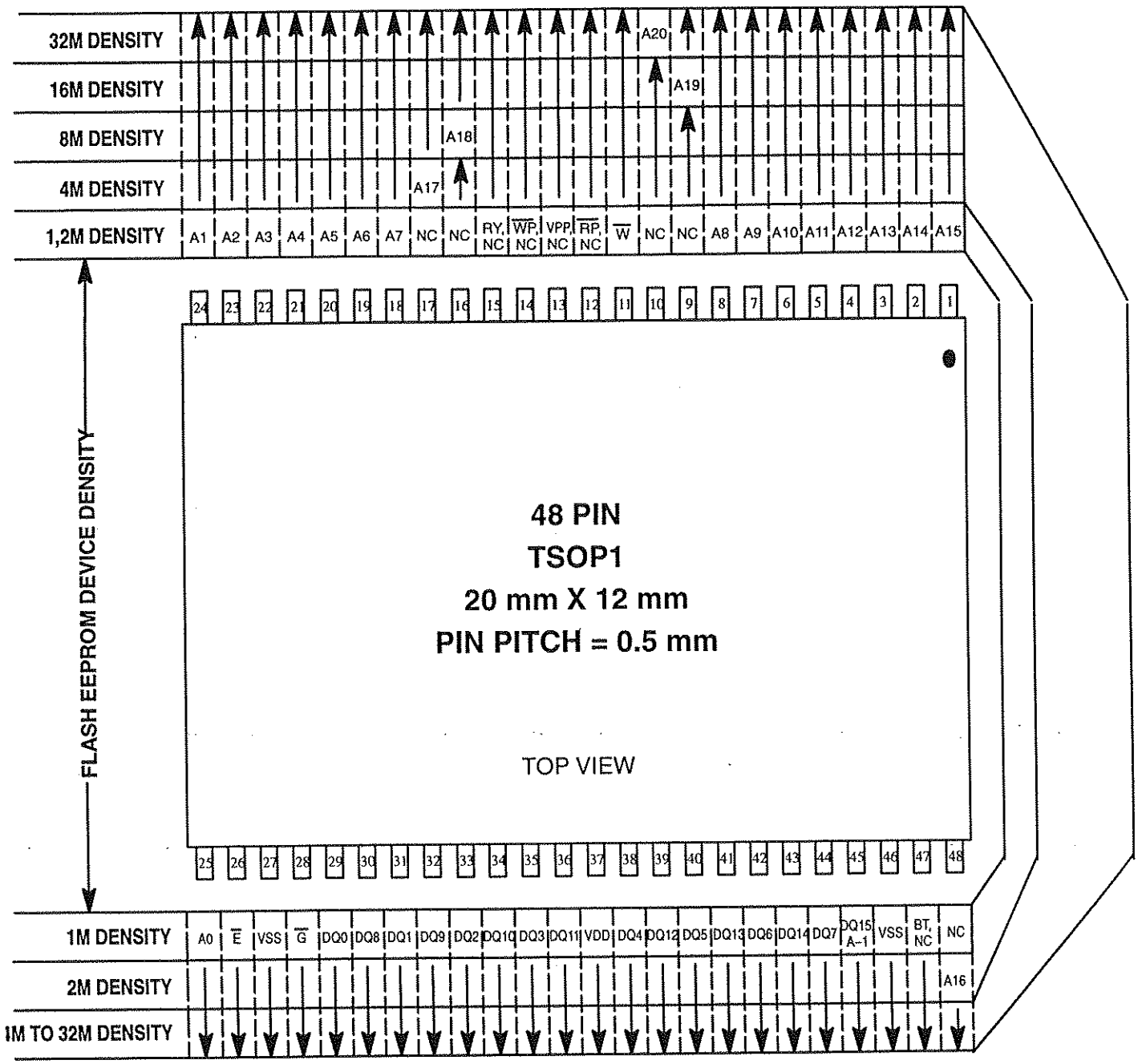



**FIGURE 3.5.2–6**
**1M, 2M, & 4M DENSITY BY 8 & 16 SINGLE OR DUAL SUPPLY FEEPROM IN PSOP, 128K TO 512K BY 8 OR 64K TO 256K BY 16**

Release 7




ORGANIZATION VS. DENSITY TABLE

| DENSITY | X16 | X8 |
|---|---|---|
| 1Mb | 64K X 16, | 128K X 8 |
| 2Mb | 128K X 16 | 256K X 8 |
| 4Mb | 256K X 16 | 512K X 8 |
| 8Mb | 512K X 16 | 1M X 8 |
| 16Mb | 1M X 16 | 2M X 8 |
| 32Mb | 2M X 16 | 4M X 8 |

**FIGURE 3.5.2–7**
**1M TO 32M DENSITY BY 8 & 16 SINGLE OR DUAL SUPPLY FEEPROM IN TSOP1, 64K TO 2M BY 16 OR 128K TO 4M BY 8**

## 3.5.3 EEPROM EXTENDED FEATURES

There are a number of extended feature standards for EEPROMS that depend on the capacity and number of power supplies used in the design. The various standards and their location are listed as follows:

– 32K X 8 BIT EEPROM EXTENDED FEATURE STANDARDS. PP 3.5.1–15 to 22

– DUAL POWER SUPPLY EEPROM COMMAND SET. Fig. 3.5.3.2, P 3.5.3–13

– EXTENDED FEATURE SET FOR EEPROM (256Kb and larger) . Sec. 3.5.3.1 following

– SINGLE POWER SUPPLY EEPROM COMMAND CODES. SEC. 3.5.3.3

– EEPROM TOGGLE BIT FEATURE (larger than 256 Kb) . Sec. 3.5.3.4

### 3.5.3.1 – EXTENDED FEATURE SET FOR EEPROM (256Kb and larger)

This standard specifies features beyond the existing pinout standards that need to be standardized for EEPROMs to achieve operational compatibility. A summary of the required and optional features is listed below. The full standard follows the pinout drawings at the end of Sec. 3.5.3.2

#### 3.5.3.1.1 – REQUIRED STANDARD FEATURES

The following features are the minimum set necessary to achieve functional compatibility for 256Kb and larger EEPROMs and must be implemented to be in compliance with this standard:

–Operate with a primary power supply of 5.0 V and lower nominal
–Operate in conformance with the defines standard command set
–Operate in conformance with the standard truth table
–Have read and write timing cycles which are consistent with the standard timing diagrams
–Contain Data & Address Latches for Write cycles
–Operate with self timed write cycles
–Operate with input levels between 0 and 5 Volts.
–DATA\ Polling

#### 3.5.3.1.2 – OPTIONAL FEATURES

The following features are optional and are not required for the part to conform to this standard. If any of these features are implemented, they must operate as defined in order to maintain compatibility and to be in compliance with this standard:

–Page Write Mode with standard write cycle timings
–Minimum page size of 16 Byte in page write mode
–Software Data Protect Option
–Hardware Mass Erase (All 1's)
–Software Mass Erase (All 1's)

### 3.5.3.2 – OPTIONAL COMMAND SET FOR DUAL–SUPPLY EEPROM

This Standard provides an optional command set for DUAL–SUPPLY EEPROM devices. This set includes the existing algorithmic commands and adds a series of automatic codes. A component may respond to either or both of the operating modes. The COMMAND SET TRUTH TABLE is shown in Figure 3.5.1–11

### 3.5.3.3 – SINGLE POWER SUPPLY EEPROM COMMAND CODES

These tables define the three cycle and 6 cycle comand codes for SINGLE SUPPLY EEPROMs with capacities greater than 256 Kb.

### 3.5.3.4 – EEPROM TOGGLE BIT FEATURE

This standard is applicable to devices with a capacity greater than 256 Kb, with both single and dual power supplies. The Toggle Bit feature is used to determine if a Write Cycle (either Erase, Program, or both) is in progress in the EEPROM or if the part is available for reading or another write cycle.

# EEPROM EXTENDED FEATURE STANDARD (256Kb and greater)

The mandatory features, whlch are the minimum set necessary to achieve functional compability for 256Kb and larger EEPROMs, must be implemented to be in compliance with this standard. Any, all, or none of the optlonal features may be implemented at the manufacturers discretlon. However, if an optional feature deflned In thls standard is implemented, it must operate as specltied in this standard to be in compllance with the standard.

Other features not described in the standard may be incorporated and the device still be in compliance as long as they are compatible wlth the required and optlonal features in this standard.

## BYTEWIDE EEPROM REQUIRED STANDARD FEATURES (256Kb and larger)

1. VDD SUPPLY IS 5 V OR LESS NOMINAL
2. STANDARD LOGIC TRUTH TABLE (FIG. A1–1)
3. STANDARD COMMAND SET (Fig. A1–2)
4. STANDARD READ CYCLE TIMING (FIG. A1–3)
5. STANDARD BYTE WRITE CYCLE FEATURES
   –TIMING (FIG. A1–4)
   –DATA AND ADDRESS LATCHES
   –SELF–TIMED WRITE CYCLES
   –ALL INPUT LEVELS IN RANGE BETWEEN 0 V AND 5 V.
6. DATA POLLING (FIG. A1–5)
   MUST MEET NORMAL READ CYCLE AND WRITE CYCLE TIMING

## OPTIONAL FEATURES

1. PAGE WRITE MODE (FIG. A1–6)
   –STANDARD PAGE WRITE CYCLE TIMING
   –16 BYTE MINIMUM PAGE SIZE (A0 – A3)
2. SOFTWARE DATA PROTECT OPTION (FIGS. A1–7 & A1–8)
3. HARDWARE MASS ERASE (ALL 1'S) (FIG. A1–9)
4. SOFTWARE MASS ERASE (ALL 1'S) (FIG. A1–10)

**EEPROM TRUTH TABLE**

| $\overline{E}$ | $\overline{G}$ | $\overline{W}$ | MODE | DQ | POWER |
|---|---|---|---|---|---|
| L | L | H | READ | Q | ACTIVE |
| L | H | L | WRITE | D | ACTIVE |
| H | X | X | STANDBY AND WRITE INHIBIT | HIGH Z | STANDBY |
| L | L | L | WRITE INHIBIT | HIGH Z | ACTIVE |
| L | H | H | WRITE INHIBIT | HIGH Z | ACTIVE |

~NOTE: $\overline{G}$ functions as both an output control and a write Inhibit control in this EEPROM Standard.

**FIGURE A1–1**

# SINGLE–SUPPLY EEPROM COMMAND SET

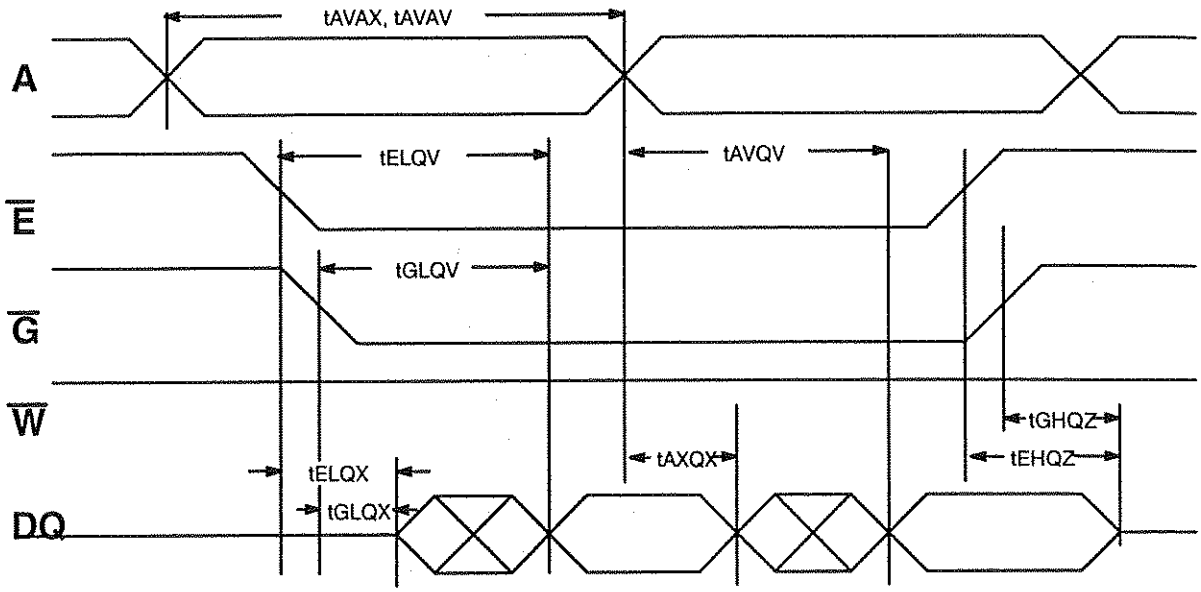
## Bus Command Table

| Command Sequence Read/Reset | Bus Write Cycles Req'd | First Bus Write Cycle | | Second Bus Write Cycle | | Third Bus Write Cycle | | Fourth Bus Read/Write Cycle | | Fifth Bus Write Cycle | | Sixth Bus Write Cycle | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Addr | Data | Addr | Data | Addr | Data | Addr | Data | Addr | Data | Addr | Data |
| Read/Reset | 1 | XXXH | FOH | | | | | | | | | | |
| Rearl/Reset | 4 | 5555H | AAH | 2AAAH | 55H | 5555H | FOH | RA | RD | | | | |
| Autoselect | 4 | 5555H | AAH | 2AMH | 55H | 5555H | 90H | | | | | | |
| Fyte Program | 4 | 5555H | AAH | 2AMH | 55H | 5555H | AOH | PA | Data | | | | |
| Chip Erase | 6 | 5555H | AAH | 2AMH | 55H | 5555H | 80H | 5555H | AAH | 2AAAH | 55H | 5555H | 1OH |
| Sector Erase | 6 | 5555H | AAH | 2AMH | 55H | 5555H | 80H | 5555H | AAH | 2AAAH | 55H | SA | 30H |
| Sector Erase Suspend | | Erase can be suspended during sector erase with Addr (don~t rare), Data (BOH) | | | | | | | | | | | |
| Sector Erase Resume | | Erase can be resumed after suspend with Addr (don~t care), Data (30H) | | | | | | | | | | | |

Note: A0 is always LSB regardless of data width.

**FIGURE A1–2**

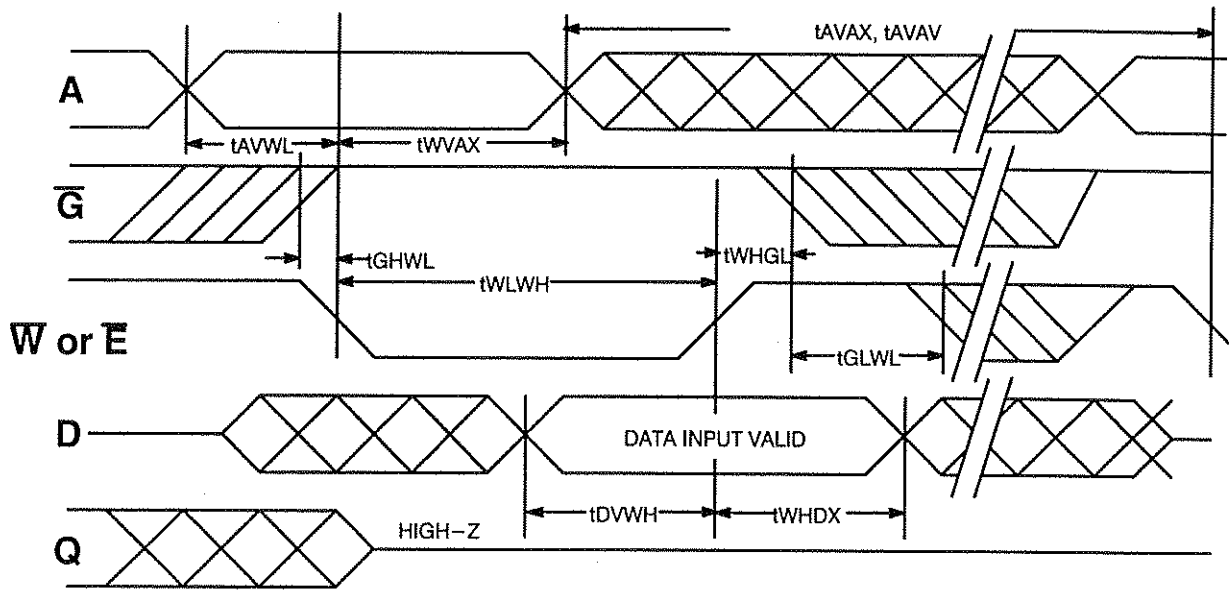
# SINGLE SUPPLY EEPROM READ CYCLE TIMING




| SYMBOL | DESCRIPTION |
|---|---|
| tAVAX, tAVAV | ADDRESS VALID TO ADDRESS CHANGE (READ CYCLE TIME) |
| tELQV | $\overline{E}$ LOW TO OUTPUT VALID (CHIP ENABLE ACCESS TIME) |
| tAVQV | ADDRESS VALID TO OUTPUT VALID (ADDRESS ACCESS TIME) tGLQV |
| tELQX | $\overline{E}$ LOW TO ACTIVE OUTPUT |
| tGLQX | $\overline{G}$ LOW TO ACTIVE OUTPUT |
| tEHQZ | $\overline{E}$ HIGH TO HIGH–Z OUTPUT |
| tGHQZ | $\overline{G}$ HIGH TO HIGH–Z OUTPUT |
| tAXQX | ADDRESS INVALID TO DATA OUT INVALID |

**FIGURE A1–3**

## SINGLE SUPPLY EEPROM READ CYCLE TIMING




| SYMBOL (NOTE 1) | DESCRIPTION |
|---|---|
| tWLWL, tELEL | $\overline{W}$ OR $\overline{E}$ LOW TO $\overline{W}$ OR $\overline{E}$ LOW CYCLE TIME (WRIITE CYCLE TIME) |
| tAVWL, tAVEL | ADDRESS VALID TO $\overline{W}$ OR $\overline{E}$ LOW TIME (ADDRESS SETUP TIME) |
| tWLAX, tELAX | $\overline{W}$ OR $\overline{E}$ LOW TO ADDRESS INVALID (ADDRESS HOLD TIME) |
| tGHWL, tGHEL | $\overline{G}$ HIGH TO $\overline{W}$ OR $\overline{E}$ LOW TIME |
| tWHGL, tEHGL | $\overline{G}$ HIGH HOLD TIME FROM $\overline{W}$ OR $\overline{E}$ HIGH |
| tWLWH, tELEH | $\overline{W}$ OR $\overline{E}$ LOW TO $\overline{W}$ OR $\overline{E}$ HIGH (WRITE PULSE DURATION) |
| tGLWL, tGLEL | $\overline{G}$ LOW TO $\overline{W}$ OR $\overline{E}$ LOW ($\overline{G}$ LOW WRITE INHIBIT SETUP TIME) |
| tDVWH, tDVEH | DATA INPUT VALID TO $\overline{W}$ OR $\overline{E}$ HIGH (DATA SET–UP TIME) |
| tWHDX, tEHDX | $\overline{W}$ OR $\overline{E}$ HIGH TO DATA INPUT INVALID (DATA HOLD TIME) |

**FIGURE A1–4**

# SINGLE SUPPLY EEPROM DATA BAR POLLING AND AUTOMATIC WRITE OPERATION STATUS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| IN PROGRESS | AUTO PROGRAMMING | DQ7 | TOGGLE | 0 | 0 | 0 | RFU |
| | PROGRAMMING IN AUTO–ERASE | 0 | TOGGLE | 0 | 0 | 1 | |
| | ERASING IN AUTO–ERASE | 0 | TOGGLE | 0 | 1 | 1 | |
| EXCEEDED TIME LIMITS | AUTO PROGRAMMING | DQ7 | TOGGLE | 1 | 0 | 0 | RFU |
| | PROGRAMMING IN AUTO–ERASE | 0 | TOGGLE | 1 | 0 | 1 | |
| | ERASING IN AUTO–ERASE | 0 | TOGGLE | 1 | 1 | 1 | |

**FIGURE A1–5**

### Definition of Automatic Algorithm

### Automated Write
### Data Command = 10h/ Byte Address and Data (1st/2nd bus cycle)

Write the automated program set–up command (10h) and program command (Byte address and program data). The device automatically times the program pulse width, provides the program verify to guarantee adequate data retention, and counts the number of pulses required for complete programming.

A data polling status bit (output pin DQ7) and a toggle bit status (output pin DQ6) provide feedback to the system as to the status of the programming operation. Either DQ7 or DQ6 can be used.

### Data Polling– DQ7

While the automated algorithms are in operation, an attempt to read the device (address = don't care) will produce the compliment of the intended valid program or erase data on DQ7. Upon completion of the automated algorithm, an attempt to read the device will produce the valid data expected from DQ7.

The data polling feature is valid after the rising edge of the second W pulse of the two write pulse sequence.

### Toggle Bit– DQ6

While the automated algorithms are in progress, successive attempts to read data (address = don't care) from the device will result in DQ6 toggling between the logic levels "1" and "O". Once the automated operation is complete, DQ6 will stop toggling and valid data will be read.

The toggle bit is valid after the rising edge of the first W pulse of the two write pulse sequence, unlike data polling which is valid after the rising edge of the second W pulse. This

feature allows the user to determine if the device is partially through the two write pulse sequence.

### Exceeded Timing Limits – DQ5

DQ5 will indicate if the program or erase pulse counts have exceeded the specified limits. Under this condition, DQ5 will provide a logic "1 " output.

### Hardware Sequence Flash – DQ4

If the device has exceeded the specified erase or program time and DQ5 is at logic level "1", then DQ4 will indicate which step in the algorithm the device exceeded limits. A logic level "O" in DQ4 indicates that the programming limits were exceeded. A logic level "1" indicates erase limits were exceeded.

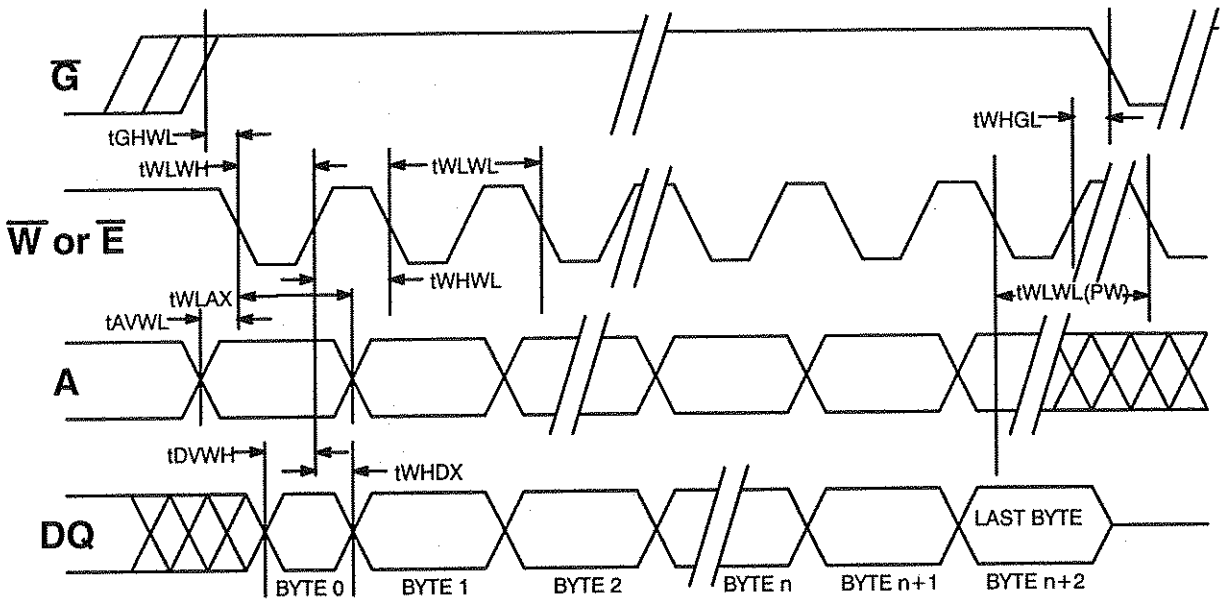
### Sector Erase Timer– DQ3

After the compietion of the initial sector erase command sequence, the sector erase time–out of 100μs will begin. If another sector erase command is written within the 100μs time–out window, the timer is reset.

If Data Polling or the Toggle bit (DQ6) indicates that the device has been written with a valid erase command, DQ3 may be used to determine if the sector erase timer window is still open. If DQ3 is at logic level "1" the internally controlled erase cycle has begun. Any further attempts to write subsequent commands to the device will be ignored untilthe erase operation is completed which is indicated by Data Polling or the Toggle bit. If DQ3 is at logic level "0", the device will accept additional sector erase commands.

### DQ0–DQ2 are reserved for future use.

# SINGLE SUPPLY EEPROM PAGE MODE WRITE CYCLE TIMING




| SYMBOL (NOTE 1) | DESCRIPTION |
|---|---|
| tWLWL(PW) | $\overline{W}$ OR $\overline{E}$ LOW TO $\overline{W}$ OR $\overline{E}$ LOW CYCLE TIME (PAGE WRIITE CYCLE TIME) |
| tAVWL, tAVEL | ADDRESS VALID TO $\overline{W}$ OR $\overline{E}$ LOW TIME (ADDRESS SETUP TIME) |
| tWLAX, tELAX | $\overline{W}$ OR $\overline{E}$ LOW TO ADDRESS INVALID (ADDRESS HOLD TIME) |
| tGHWL, tGHEL | $\overline{G}$ HIGH TO $\overline{W}$ OR $\overline{E}$ LOW TIME |
| tWHGL, tEHGL | $\overline{G}$ HIGH HOLD TIME FROM $\overline{W}$ OR $\overline{E}$ HIGH |
| tWLWH, tELEH | $\overline{W}$ OR $\overline{E}$ LOW TO $\overline{W}$ OR $\overline{E}$ HIGH (WRITE PULSE DURATION) |
| tDVWH, tDVEH | DATA INPUT VALID TO $\overline{W}$ OR $\overline{E}$ HIGH (DATA SET–UP TIME) |
| tWHDX, tEHDX | $\overline{W}$ OR $\overline{E}$ HIGH TO DATA INPUT INVALID (DATA HOLD TIME) |
| tWLWL, tELEL | $\overline{W}$ OR $\overline{E}$ LOW TO $\overline{W}$ OR $\overline{E}$ LOW (BYTE LOAD CYCLE TIME) |

**FIGURE A1–6**

# SINGLE SUPPLY EEPROM OPTIONAL SOFTWARE DATA PROTECTION

–SOFTWARE DATA PROTECTION IS A DIFFERENT METHOD OF PREVENTING INADVERTANT WRITE OPERATIONS IN A NONVOLATILE MEMORY COMPARED TO THE "HARDWAREU METHODS, SUCH AS: E, G, AND W LOGIC COMBINATIONS, VCC LEVEL DETECTORS, AND POWER UP TIMERS.

–A SPECIFIC DATA AND ADDRESS SOFTWARE SEQUENCE MUST BE ISSUED TO ENABLE A SINGLE PAGE OR BYTE WRITE.

–DATA INPUT FORMAT: D7/D6/D5/D4/D3/D2/D1/D0

–ADDRESS FORMAT: A14/A13/A12/A11/A10/A9/A8/A7/A6/A5/A4/A3/A2/A1/A0

| STEP | MODE | A14–A0 | DQ7–DQ0 |
|---|---|---|---|
| 1 | "ACCESS WRITE" | 5555H | AAH |
| 2 | "ACCESS WRITE" | 2AAAH | 55H |
| 3 | "ACCESS WRITE" | 5555H | A0H |
| 4 | "PAGE WRITE" | Address | Data |

–ALL WRITES MUST CONFORM TO THE PAGE MODE TIMING REQUIREMENTS FOR THE PART.

–SINCE THE PAGE ADDRESS IS CHANGED (A VIOLATION OF THE NORMAL PAGE MODE WRITE CYCLE), THE FIRST THREE "ACCESS" WRITES (STEPS 1–3) ARE USED ONLY FOR SOFTWARE ACCESS, NO DATA IS ACTUALLY WRITTEN TO THE EEPROM.

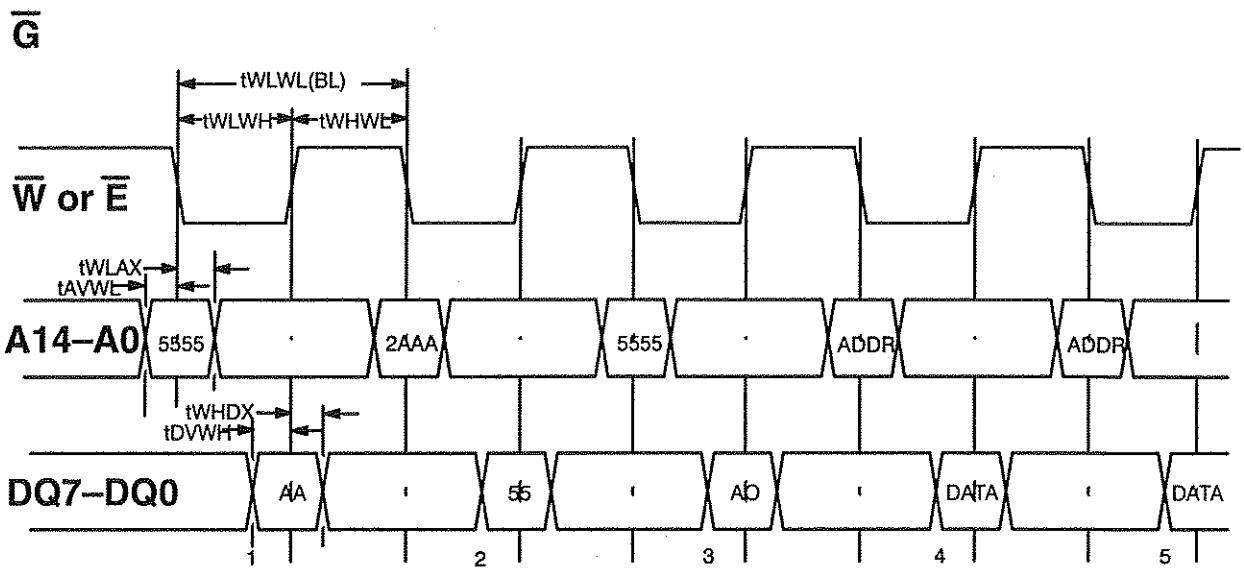
–THE FIRST TIME THIS SEQUENCE IS APPLIED TO THE PART A NON–VOLATILE BIT IS SET, WHICH RECONFIGURES THE PART FROM HARDWARE PROTECTED ONLY TO HARDWARE AND SOFTWARE SEQUENCE PROTECTED. ONCE THIS BIT IS SET, THE SOFTWARE SEQUENCE MUST BE USED TO WRITE TO THE PART.

–THE SOFTWARE PROTECTION CAN BE DISABLED AND THE PART RECONFIGURED TO HARDWARE–ONLY PROTECTION, BY APPLYING THE SIX STEP SOFTWARE SEQUENCE BELOW:

| STEP | MODE | A14–A0 | DQ7–DQ0 |
|---|---|---|---|
| 1 | "ACCESS" WRITE | 5555H | AAH |
| 2 | "ACCESS" WRITE | 2AAAH | 55H |
| 3 | "ACCESS" WRITE | 5555H | 80H |
| 4 | "ACCESS" WRITE | 5555H | AAH |
| 5 | "ACCESS" WRITE | 2AAAH | 55H |
| 6 | "ACCESS" WRITE | 5555H | 20H |

## FIGURE A1–7

# SINGLE SUPPLY EEPROM SOFTWARE DATA PROTECTION TIMING




NOTE 5: Software Data Protection Timings are referenced to $\overline{W}$ or $\overline{E}$ Inputs, whichever is last going LOW, and the $\overline{W}$ or $\overline{E}$ Inputs, whichever is first going HIGH.

| SYMBOL (NOTE 5) | DESCRIPTION |
|---|---|
| tWLWL(BL), tELEL(BL) | $\overline{W}$ OR $\overline{E}$ LOW TO $\overline{W}$ OR $\overline{E}$ LOW BYTE LOW CYCLE TIME |
| tWLWH, tELEH | $\overline{W}$ OR $\overline{E}$ LOW TO $\overline{W}$ OR $\overline{E}$ HIGH (WRITE PULSE DURATION) |
| tWHWL, tEHEL | $\overline{W}$ OR $\overline{E}$ HIGH TO $\overline{W}$ OR $\overline{E}$ LOW TIME (WRITE HIGH RECOVERY) |
| tAVWL tAVEL | ADDRESS VALID TO $\overline{W}$ OR $\overline{E}$ LOW TIME (ADDRESS SET–UP TIME) |
| tWLAX, ELAX | $\overline{W}$ OR $\overline{E}$ LOW TO ADDRESS INVALID TIME (ADDRESS HOLD TIME) |
| tDVWH, tDVEH | DATA INPUT VALID TO $\overline{W}$ OR $\overline{E}$ HIGH (DATA SET–UP TIME) |
| tWHDX. tEHDX | $\overline{W}$ OR $\overline{E}$ HIGH TO DATA INPUT INVALID (DATA HOLD TIME) |

**FIGURE A1–8**

## SINGLE SUPPLY EEPROM OPTIONAL HARDWARE MASS ERASE (ALL 1'S) FEATURE

– IF A HARDWARE MASS ERASE MODE IS IMPLEMENTED ON THE 256K EEPROM, THE FOLLOWING CONVENTIONS MUST BE FOLLOWED:

– $\overline{E}$ = LOW LOGIC LEVEL

– $\overline{W}$ = LOW LOGIC LEVEL

– $\overline{G}$ = SUPER VOLTAGE (WAVEFORM, LEVEL AND TIMING TO BE DETERMINED BY THE MANUFACTURER).

– DQ0 – DQ7 = ALL HIGH LOGIC LEVEL (FFH)

– A0 – A14 = DON'T CARE (EITHER HIGH OR LOW LOGIC LEVELS)

## FIGURE A1–9

## SINGLE SUPPLY BIT EEPROM OPTIONAL SOFTWARE MASS ERASE (ALL 1'S) FEATURE

IF A SOFTWARE MASS ERASE FEATURE IS IMPLEMENTED IN THE SINGLE SUPPLY EEPROM, IT MUST OPERATE BY APPLYING THE FOLLOWING SIX DATA/ADDRESS SEQUENCE TO THE PART.

| STEP | MODE | A14–A0 | DQ7–DQ0 |
|---|---|---|---|
| 1 | "ACCESS" WRITE | 5555H | AAH |
| 2 | "ACCESS" WRITE | 2AAAH | 55H |
| 3 | "ACCESS" WRITE | 5555H | 80H |
| 4 | "ACCESS" WRITE | 5555H | AAH |
| 5 | "ACCESS" WRITE | 2AAAH | 55H |
| 6 | "ACCESS" WRITE | 5555H | 10H |

–ALL ACCESS WRITES MUST FOLLOW THE STANDARD PAGE MODE WRITE CYCLE TIMING SPECIFIED FOR THE PART,

–NO DATA IS ACTUALLY WRITTEN TO THE EEPROM DURING THE "ACCESS" WRITES. ONCE THE 6 STEP SEQUENCE IS COMPLETED, THE PART AUTOMATICALLY COMPLETES A MASS ERASE CYCLE INTERNALLY.

## FIGURE A1–10



XILINX EXHIBIT 1012
Page 86

### 3.5.3.2 – DUAL POWER SUPPLY EEPROM COMAND SET

The following command set is applicable to dual power supply EEPROMs of any capacity.

| COMAND CODES | | |
|---|---|---|
| 1st CYCLE | 2nd CYCLE | OPERATION DESCRIPTION |
| 00 | | RESERVED |
| 10 | | Automated Write |
| 20 | 20 | Automated Block Erase |
| 20 | D0 | Automated Block Erase |
| 30 | 30 | Automated Chip Erase |
| 40 | | Algorithmic Write |
| 50 | | Reserved |
| 60 | 60 | Algorithmic Block Erase |
| 70 | | Reserved |
| 80 | | Reserved |
| 90 | | Read ID |
| A0 | | Algorithmic Erase Verify |
| B0 | | Reserved |
| C0 | | Algorithmic Write Verify |
| D0 | | Reserved |
| E0 | | Reserved |
| F0 | | |

NOTE: All operands are in HEX.

This Standard provides an optional command set for use with the dual supply voltage EEPROM devices. This command set comprehends algorithmic commands and adds a set of automatic codes. A device may respond to either or both operating modes.

The Standard is applicable to devices with all data interface widths..

### 3.5.3.3 – SINGLE POWER SUPPLY EEPROM COMMAND CODES

The following tables define the three cycle and 6 cycle comand codes for SINGLE SUPPLY EEPROMs with capacities greater than 256 Kb.

Three cycle Command Codes

| Command | 1st Cycle | | 2nd Cycle | | 3rd Cycle | |
|---|---|---|---|---|---|---|
| | Address | Data | Address | Data | Address | Data |
| SDP Write Disable | 5555 | AA | 2AAA | 55 | 5555 | A0 |
| Product Identification Entry | 5555 | AA | 2AAA | 55 | 5555 | 90 |
| Reset/Product Identification Exit | 5555 | AA | 2AAA | 55 | 5555 | F0 |
| Note: All operands are in HEX. | | | | | | |

Six Cycle Command Codes

| | 1st Cycle | | 2nd Cycle | | 3rd Cycle | | 4th Cycle | | 5th Cycle | | 6th Cycle | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Command | Addr | Data | Addr | Data | Addr | Data | Addr | Data | Addr | Data | Addr | Data |
| SDP Write Disable | 5555 | AA | 2AAA | 55 | 5555 | 80 | 5555 | AA | 2AAA | 55 | 5555 | 20 |
| Chip Clear (Erase) | 5555 | AA | 2AAA | 55 | 5555 | 80 | 5555 | AA | 2AAA | 55 | 5555 | 10 |
| Note: All operands are in HEX | | | | | | | | | | | | |

All timings are per the EEPROM Software Data Protect Timing shown in Fig. A1–7

The address space required is encompassed by A0–A14; other address lines, e.g., A15, A16, can be at any level between VSS minimum and VCC maximum. The data space required is encompassed by DQ0–DQ7; other I/O lines, DQ8, DQ9, can be at any level between VSS minimum and VCC maximum.

### 3.5.3.4 – EEPROM TOGGLE BIT FEATURE

This standard is applicable to devices with a capacity greater than 256 Kb, with both single and dual power supplies.

–The Toggle Bit feature is used to determine if a Write Cycle (either Erase, Program, or both) is in progress in the EEPROM or if the part is available for reading or another write cycle.

–Whenever the part is read during a nonvolatile write cycle, the data on DQ6 will toggle, i.e., alternate between high and low, on alternate read cycles. Any address can be used when reading to get the Toggle Bit output. Typically, the first toggle out is high (logic "1").

–When the nonvolatile write cycle automatically times out, normal valid data is read at the outputs for any provided address.

–A software routine uses this feature to determine when the nonvolatile write cycle is complete.

–The normal read cycle timing specified for the part must be used for Toggle Bit read cycles.

–An additional parameter, tWHGL (tEHGL), must also be specified for the toggle bit cycle. tWHGL (tEHWL) is the minimum time the system must wait from the last rising edge of $\overline{W}$ ($\overline{WE}$) or $\overline{E}$ until the Toggle Bit read cycle is initiated by the falling edge of $\overline{G}$ ($\overline{OE}$).

–The actual completion of the nonvolatile write cycle is asynchronous with the system; therefore, a Toggle Bit read may be simultaneous with the completion of the write cycle. If this occurs, the system will possibly get an erroneous result, i.e., valid data may appear to conflict with DQ6. In order to prevent spurious rejections, if an erroneous result occurs, the software routine should include a loop to read the accessed location an additional two (2) times. If both reads are valid, then the device has completed the write cycle, otherwise the reject is valid.

**3.7.5.10 – 32K and 128K BY 8 TTL SSRAM IN DIP AND SOJ**

CAPACITY—32K, & 128K WORDS OF 8 BIT
LOGIC FEATURES—SEPARATE DATA INPUT & OUTPUT PINS
—OUTPUT ENABLE
PACKAGE—40 PIN DIP, 0.6" wide
—40 PIN SOJ, UNDEFINED
SPECIAL FEATURES—MULTIPLE CENTERED POWER PINS
PIN ASSIGNMENT—Fig. 3.7.5–10

**3.7.5.11 – 2K TO 32K BY 9 DPSRAM FAMILY IN 68 SCC**

CAPACITY—2K, 8K, 32K WORDS OF 9 BITS,
LOGIC FEATURES—Two identical access ports
PACKAGE—68 PAD (PIN) SCC, 0.950" X 0.950"
PIN ASSIGNMENT—Fig. 3.7.5–11
This part contains two identical ports for access to the storage array. These ports include full sets of address, data, and control signals.

**3.7.5.12 – 32K BY 9 CACHE SRAM IN 44 SCC**

CAPACITY—32K WORDS OF 9 BITS,
LOGIC FEATURES—Internal CACHE data compare logic
PACKAGE—44 TERMINAL SCC, 0.500" X 0.500"
PIN ASSIGNMENT—Fig. 3.7.5–12
This part contains specialized logic functions which allow it to be used to implement the CACHE memory function conveniently.

**3.7.5.13 – 128K BY 8 SRAM IN TSOP1**

CAPACITY—128K WORDS OF 8 BITS
PACKAGE—32 PIN TSOP1, 20 mm X 8 mm, 0.5 mm PIN PITCH
PIN ASSIGNMENTS—Fig. 3.7.5–13

**3.7.5.14 – 128K BY 8 & 9 SSRAM IN SOJ**

CAPACITY—128K WORDS OF 8 BITS
PACKAGE—32 PIN SOJ, 0.400"
PIN ASSIGNMENTS—Fig. 3.7.5–14

**3.7.5.15 – 1K AND 2K BY 8 DPSRAM FAMILY IN 48 DIP**

CAPACITY—1K, 2K WORDS OF 8 BITS,
LOGIC FEATURES—Two identical access ports
PACKAGE—48 PIN DIP, 0.600"
PIN ASSIGNMENT—Fig. 3.7.5–15
This part contains two identical ports for access to the storage array. These ports include full sets of address, data, and control signals.

**3.7.5.16 – 128K TO 512K BY 8 SRAM FAMILY IN 32 CDSO–N**

CAPACITY—128K, 256K, 512K WORDS OF 8 BITS,
PACKAGE—32 PIN LEADLESS CERAMIC SO, 0.400"
PIN ASSIGNMENT—Fig. 3.7.5–16
This family of parts is based on the evolutionary SRAM pinout family described in Sec. 3.7.5.7

**3.7.5.17 – 128K TO 512K BY 8 & 9 SSRAM AND 128K BY 9 SRAM IN 33 DIP, TSOP2, AND SOJ**

CAPACITY—128K & 512K WORDS OF 8 OR 9 BITS,
LOGIC FEATURES—Both Synchronous and Asynchronous versions of the 128K part
PACKAGE—36 PIN DIP, TSOP2, or SOJ, 0.400" or 0.600",
— See Fig. 3.7.5–17 for specific package approvals and dimensions.
PIN ASSIGNMENT—Fig. 3.7.5–17

**Release 7**

**3.7.5.18 – 128K TO 2M BY 8/9 BURST SRAM IN BGA**

CAPACITY—128K, 256K, 512K, 1M, 2M WORDS OF 8 OR 9 BITS,
PACKAGE—7 X 17 BALL BGA 14 mm X 22 mm or UNDEFINED
PIN ASSIGNMENT—Fig. 3.7.5–18
These parts contain BURST addressing capability.

**3.7.5.19 – 128K TO 2M BY 8/9 SSRAM IN BGA**

CAPACITY—128K, 256K, 512K, 1M, 2M WORDS OF 8 OR 9 BITS,
PACKAGE—7 X 17 BALL BGA 14 mm X 22 mm or UNDEFINED
PIN ASSIGNMENT—Fig. 3.7.5–19
Included with this standard is a table of the BOUNDRY SCAN ORDER to be used in testing the parts.
BOUNDRY SCAN ORDER TABLE—Fig. 3.7.5–20

**3.7.5.20 – 32K BY 8 SRAM IN TSOP1**

CAPACITY—32K WORDS OF 8 BITS
PACKAGE—32 PIN TSOP1, 8 mm X 11.8 mm, 0.55 mm PP
PIN ASSIGNMENTS—Fig. 3.7.5–21

## 3.7.5 Byte Wide TTL SRAM

All of the following standards are for devices which operate with TTL interface levels and power voltages.

**3.7.5.1 – 64 BY 9 TTL SRAM IN SCC**

CAPACITY—64 WORDS OF 9 BITS
PACKAGE—28 PAD (PIN) SCC, 0.450" X 0.450"
PIN ASSIGNMENTS—Fig. 3.7.5–1
This standard was developed by Committee 42.1.

**3.7.5.2 – 1K & 2K BY 8 TTL SRAM IN DIP**

CAPACITY—1K, 2K WORDS OF 8 BITS
PACKAGE—24 PIN DIP, 0.6" WIDE
PIN ASSIGNMENT—Fig. 3.7.5–2

**3.7.5.3 – 2K & 4K BY 8 TTL SRAM IN RCC**

CAPACITY—2K, 4K WORDS OF 8 BITS
PACKAGE—32 PAD (PIN) RCC, 0.450" BY 0.550"
PIN ASSIGNMENT—Fig. 3.7.5–3
These parts are CC equivalents of 24 Pin DIP devices.

**3.7.5.4 – 2K TO 32K BY 8 TTL SRAM FAMILY IN DIP & SOJ,**

CAPACITY—2K, 4K, 8K, 16K, & 32K WORDS OF 8 BITS,
PACKAGE—28 PIN DIP, 0.6" WIDE
—28 PIN DIP, 0.3" WIDE OPTIONAL FOR 8K & 32K DEVICES
PIN ASSIGNMENT—Fig. 3.7.5–4

**3.7.5.5 – .5K TO 32K BY 8 TTL SRAM FAMILY IN RCC**

CAPACITY—.5K, 1K, 2K, 4K, 8K, 16K, 32K WORDS OF 8 BITS
PACKAGE—32 PAD (PIN) RCC, 0.450" BY 0.550"
PIN ASSIGNMENT—Fig. 3.7.5–5

**3.7.5.6 – 32K TO 512K BY 8 TTL SRAM FAMILY IN SOJ or TSOP–2,**

CAPACITY—32K, 128K, 256K, 512K WORDS OF 8 BITS,
PACKAGE—28 OR 32 PIN SOJ, 0.3", 0.4" WIDE OR NOT DEFINED
—32 PIN TSOP–2 (see Fig. 3.7.5–6 for package approvals)
PIN ASSIGNMENT—Fig. 3.7.5–6

**3.7.5.7 – 64K TO 512K BY 8 TTL SRAM FAMILY IN DIP,**

CAPACITY—64K, 128K, 256K, 512K WORDS OF 8 BITS,
PACKAGE—32 PIN DIP, 0.6" WIDE
PIN ASSIGNMENT—Fig. 3.7.5–7

**3.7.5.8 – 32K TO 256K BY 9 TTL SRAM FAMILY IN DIP,**

CAPACITY—32K, 64K, 128K, 256K WORDS OF 9 BITS,
PACKAGE—32 PIN DIP, 0.6" WIDE
—OPTIONAL 32 PIN DIP & SOJ, 0.3" WIDE FOR 32K DEVICE
PIN ASSIGNMENT—Fig. 3.7.5–8

**3.7.5.9 – 32K TO 2M BY 8 AND 512K TO 2M BY 9 TTL SRAM IN DIP, SOJ, AND TSOP–2**

CAPACITY—32K, 128K, 512K, 2M WORDS OF 8 BIT AND 512K, 2M WORDS OF 9 BITS
LOGIC FEATURES—COMMON DATA INPUT & OUTPUT PINS
—OUTPUT ENABLE FOR ALL DENSITIES
PACKAGE—32, 36, or 40 PIN SOJ, & TSOP–2, 0.3", 0.4". or 0.5" WIDE with PP=0.05"
—32 or 36 PIN DIP, 0.3", 0.4" with PP=0.1", or 0.6" with PP=0.07".
SPECIAL FEATURES—MULTIPLE CENTERED POWER PINS
PIN ASSIGNMENT—Fig. 3.7.5–9

| SSRAM Boundry Scan Order | | | | | |
|---|---|---|---|---|---|
| X9 Part | | | | | |
| Exit Order | Signal | Bump # | | Exit Order | Signal | Bump # |
| 1 | M2, NC | 5R | | 22 | NC, $\overline{SA}$ | 3B |
| 2 | SA | 6T | | 23 | NC, SE2 SA# | 2B |
| 3 | SA | 4P | | 24 | SA | 3A |
| 4 | SA | 4T | | 25 | SA | 3C |
| 5 | SA | 6R | | 26 | SA | 2C |
| 6 | SA | 5T | | 27 | SA | 2A |
| 7 | NC, ZZ | 7T | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| 8 | DQ | 6L | | 28 | DQ | 2G |
| | | | | | | |
| | | | | | | |
| 9 | DQ | 7K | | 29 | DQ | 1H |
| | | | | | | |
| 10 | $\overline{K}$, NC | 4L | | 30 | ZQ, NC | 4D |
| 11 | K | 4K | | 31 | $\overline{SS}$ | 4E |
| 12 | $\overline{G}$ | 4F | | 32 | $\overline{C}$, NC | 4G |
| | | | | 33 | C, NC | 4H |
| | | | | 34 | $\overline{SW}$ | 4M |
| | | | | | | |
| 13 | DQ | 6H | | | | |
| 14 | DQ | 7G | | 35 | DQ | 2K |
| | | | | 36 | DQ | 1L |
| | | | | | | |
| 15 | DQ, NC | 7E | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| 16 | SA | 6A | | | | |
| 17 | SA | 6C | | 37 | SA | 3T |
| 18 | SA | 5C | | 38 | SA | 2R |
| 18 | SA | 5A | | 39 | SA | 4N |
| 20 | NC, $\overline{SE2}$ SA◇ | 6B | | 40 | SA | 2T |
| 21 | NC, SA* | 5B | | 41 | M1, NC | 3R |

**FIGURE 3.7.5-20**

**128K TO 2M BY 8/9 SSRAM IN BGA BOUNDRY SCAN ORDER**

**Release 4**

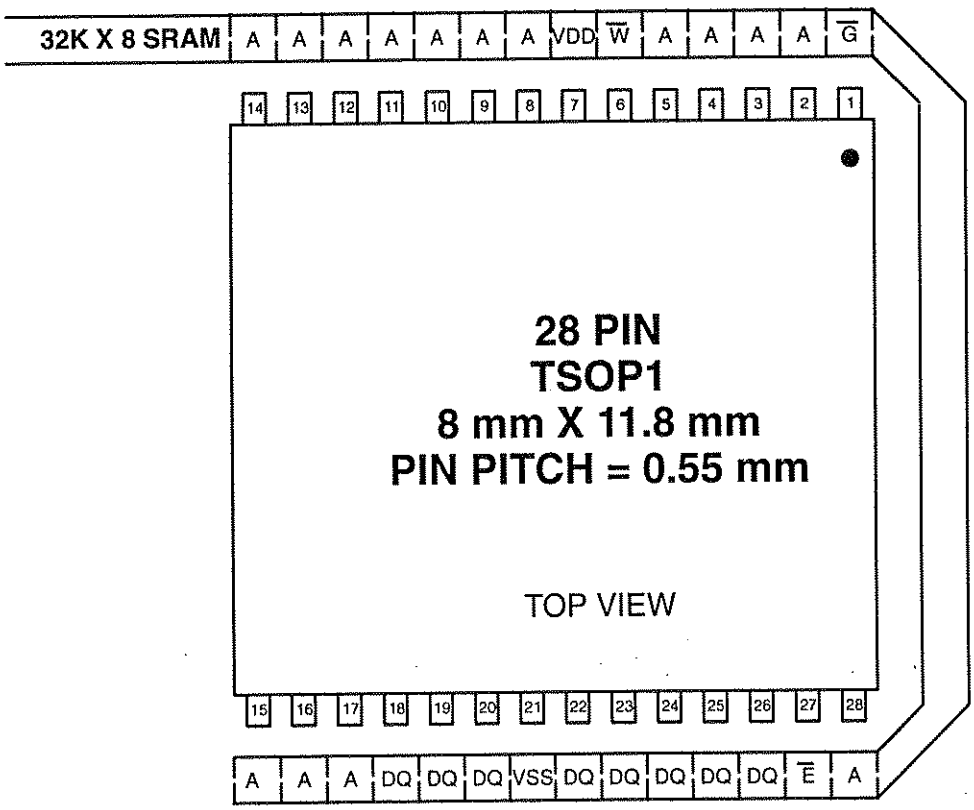



**FIGURE 3.7.5–21**
**32K BY 8 SRAM IN TSOP–1**

| Synchronous SRAM Ball Grid Array (BGA) Package Bump Assignments, Top View | | | | | | | |
|---|---|---|---|---|---|---|---|
| X18 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| A | VDDQ | SA | SA | NC | SA | SA | VDDQ |
| B | NC | NC,SE2,SA# | NC, SA~ | NC | NC, SA* | NC,$\overline{SE2}$,SA◇ | NC |
| C | NC | SA | SA | VDD | SA | SA | NC |
| D | DQb | NC | VSS | NC, ZQ | VSS | DQa, NC | NC |
| E | NC | DQb | VSS | $\overline{SS}$, $\overline{SE}$ | VSS | NC | DQa |
| F | VDDQ | NC | VSS | $\overline{G}$, $\overline{SG}$ | VSS | DQa | VDDQ |
| G | NC | DQb | $\overline{SBb}$ | NC, $\overline{C}$ | VSS | NC | DQa |
| H | DQb | NC | VSS | NC, C | VSS | DQa | NC |
| J | VDDQ | VDD | VREF, NC | VDD | VREF, NC | VDD | VDDQ |
| K | NC | DQb | VSS | CK, K | VSS | NC | DQa |
| L | DQb | NC | VSS | $\overline{CK}$, $\overline{K}$, NC | $\overline{SBa}$ | DQa | NC |
| M | VDDQ | DQb | VSS | $\overline{SW}$ | VSS | NC | VDDQ |
| N | DQb | NC | VSS | SA | VSS | DQa | NC |
| P | NC | DQb, NC | VSS | SA | VSS | NC | DQa |
| R | NC | SA | M1, NC | VDD | M2, NC | SA | NC |
| T | NC | SA | SA | NC | SA | SA | ZZ, NC |
| U | VDDQ | TMS, NC | TDI, NC | TCK, NC | TDO, NC | NC, TRST | VDDQ |

| Address Assignment and Package Dimension Table | | |
|---|---|---|
| **Density** | **Address Assignment** | **Nominal Exterior Package Dimension** |
| 1M (64K X 18) | Basic SA | 14 mm X 22 mm |
| 2M (128K X 18) | ~ | 14 mm X 22 mm |
| 4M (256K X 18) | ~, * | 14 mm X 22 mm |
| 8M (512K X 18) | ~, *, ◇ | TBD |
| 16 M (1M X 18) | ~, *. ◇, # | TBD |

| Mode Truth Table | M1 | M2 |
|---|---|---|
| Single Clock, Register Flow Through | VSS | VSS |
| Single Clock, Register–Register | VSS | VDD |
| Single Clock, Register–Latch | VDD | VSS |
| Dual Clock | VDD | VDD |

## FIGURE 3.7.7–10
## 64K TO 1M BY 16 & 18 SSRAM IN BGA

| SSRAM Boundry Scan Order | | | | | | |
|---|---|---|---|---|---|---|
| X18 Part | | | | | | |
| Exit Order | Signal | Bump # | | Exit Order | Signal | Bump # |
| 1 | M2, NC | 5R | | 26 | NC, SA~ | 3B |
| 2 | SA | | | 27 | NC, SE2 SA# | 2B |
| 3 | SA | 6T | | 28 | SA | 3A |
| | | 4P | | 29 | SA | 3C |
| 4 | SA | 6R | | 30 | SA | 2C |
| 5 | SA | 5T | | 31 | SA | 2A |
| 6 | NC, ZZ | 7T | | | | |
| | | | | 32 | DQB | 1D |
| 7 | DQa | 7P | | 33 | DQb | 2E |
| 8 | DQa | 6N | | | | |
| | | | | | | |
| | | | | 34 | DQb | 2G |
| 9 | DQa | 6L | | | | |
| | | | | | | |
| | | | | 35 | DQb | 1H |
| 10 | DQa | 7K | | 36 | $\overline{SBb}$ | 3G |
| 11 | $\overline{SBa}$ | 5L | | 37 | ZQ, NC | 4D |
| 12 | $\overline{K}$, NC | 4L | | 38 | $\overline{SS}$ | 4E |
| 13 | K | 4K | | 39 | $\overline{C}$, NC | 4G |
| 14 | G | 4F | | 40 | C, NC | 4H |
| | | | | 41 | $\overline{SW}$ | 4M |
| | | | | | | |
| 15 | DQa | 6H | | | | |
| 16 | DQa | 7G | | 42 | DQb | 2K |
| | | | | 43 | DQb | 1L |
| 17 | DQa | 6F | | | | |
| 18 | DQa | 7E | | 44 | DQb | 2M |
| | | | | 45 | DQb | 1N |
| | | | | | | |
| 19 | DQa, NC | 6D | | | | |
| 20 | SA | 6A | | 46 | DQb, NC | 2P |
| 21 | SA | 6C | | 47 | SA | 3T |
| 22 | SA | 5C | | 48 | SA | 2R |
| 23 | SA | 5A | | 49 | SA | 4N |
| 24 | NC, $\overline{SE2}$ SA◇ | 6B | | 50 | SA | 2T |
| 25 | NC, SA* | 5B | | 51 | M1, NC | 3R |

**FIGURE 3.7.7–11**
**64K TO 1M BY 16 & 18 SSRAM IN BGA BOUNDRY SCAN ORDER**

**Release 5c7**

**3.7.8.1 – 32K TO 128K BY 32 & 36 BURST SSRAM IN TQFP**

CAPACITY—32K, 64K, OR 128K, WORDS OF 32 OR 36 BITS,
PACKAGE—100 PIN TQFP, 20 mm X 14 mm WITH 0.65 mm PP
PIN ASSIGNMENT—Fig. 3.7.8–1
These parts combine the features of Synchronous SRAM with BURST addressing capability. This standard modifies the one published previously in Release 5 ab adding new functions and deleting some that were not used.

**3.7.8.2 – 32K TO 128K BY 32 & 36 SRAM AND SSRAM FAMILIES IN 100 TQFP**

CAPACITY—32K, 64K, OR 128K, WORDS OF 32 OR 36 BITS,
LOGIC FEATURES —There are two version of this part available:
—SYNCHRONOUS WITH ADDRESS LATCH OR ASYNCHRONOUS
—UPPER BYTE AND LOWER BYTE SELECTABLE
—COMMON DATA I/O
PACKAGE—100 PIN TQFP, 20 mm X 14 mm 0.65 mm PP
PIN ASSIGNMENT—Fig. 3.7.8–2

**3.7.8.3 – 32K TO 512K BY 32 & 36 BURST SRAM IN BGA**

CAPACITY—32K, 64K,128K, 256K, OR 512K WORDS OF 32 OR 36 BITS,
PACKAGE—7 X 17 BALL BGA 14 mm X 22 mm or UNDEFINED
PIN ASSIGNMENT—Fig. 3.7.8–3
These parts contain BURST addressing capability.

**3.7.8.4 – 32K TO 512K BY 16 & 18 SSRAM IN BGA**

CAPACITY—32K, 64K, 128K, 256K, OR 512K WORDS OF 32 OR 36 BITS,
PACKAGE—7 X 17 BALL BGA 14 mm X 22 mm or UNDEFINED
PIN ASSIGNMENT—Fig. 3.7.8–4
.Included with this standard is a table of the BOUNDRY SCAN ORDER to be used in testing the parts.
BOUNDRY SCAN ORDER TABLE—Fig. 3.7.8–5

**3.7.8.5 – 16K TO 64K BY 64 & 72 BURST SSRAM IN QFP**

CAPACITY—32K, 64K, OR 128K, WORDS OF 32 OR 36 BITS,
PACKAGE—120 PIN TQFP, 20 mm X 14 mm WITH 0.5 mm PP
PIN ASSIGNMENT—Fig. 3.7.8–6
These parts combine the features of Synchronous SRAM with BURST addressing capability.

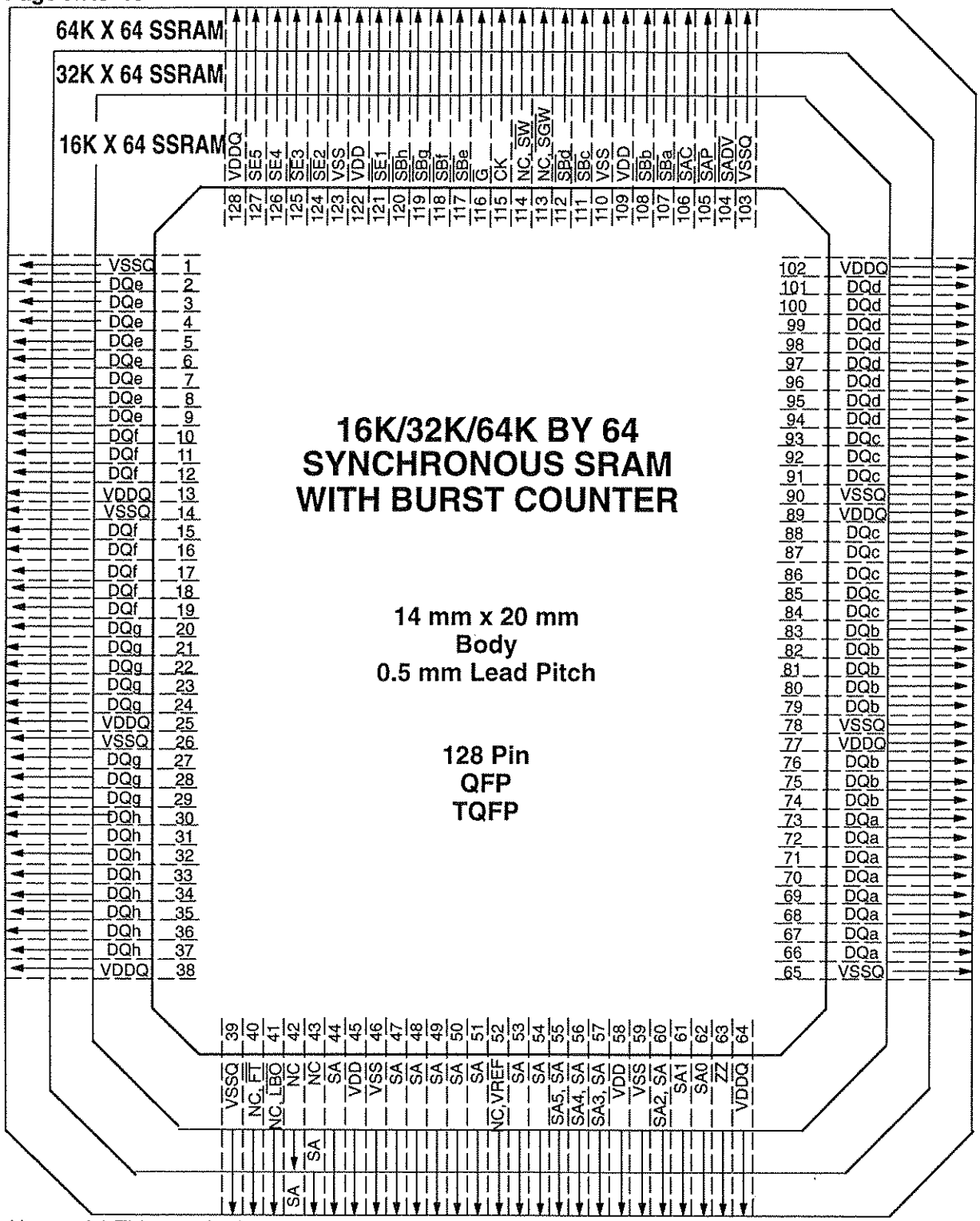
**3.7.8.6 – 16K TO 256K BY 64 & 72 BURST SSRAM IN BGA**

CAPACITY—16K, 32K, 64K, 128K, OR 256K WORDS OF 64 OR 72 BITS,
PACKAGE—11 X 19 BALL BGA 20 mm X 25 mm OR UNDEFINED
PIN ASSIGNMENT—Fig. 3.7.8–7
These parts combine the features of Synchronous SRAM with BURST addressing capability.

| SSRAM Boundry Scan Order | | | | | |
|---|---|---|---|---|---|
| X36 Part | | | | | |
| Exit Order | Signal | Bump # | | Exit Order | Signal | Bump # |
| 1 | M2, NC | 5R | | 36 | NC, $\overline{SA}$ | 3B |
| | | | | 37 | NC, SE2 SA# | 2B |
| 2 | SA | 4P | | 38 | SA | 3A |
| 3 | SA | 4T | | 39 | SA | 3C |
| 4 | SA | 6R | | 40 | SA | 2C |
| 5 | SA | 5T | | 41 | SA | 2A |
| 6 | NC, ZZ | 7T | | 42 | DQc,NC | 2D |
| 7 | DQa, NC | 6P | | 43 | DQc | 1D |
| 8 | DQa | 7P | | 44 | DQc | 2E |
| 9 | DQa | 6N | | 45 | DQc | 1E |
| 10 | DQa | 7N | | 46 | DQc | 2F |
| 11 | DQa | 6M | | 47 | DQc | 2G |
| 12 | DQa | 6L | | 48 | DQc | 1G |
| 13 | DQa | 7L | | 49 | DQc | 2H |
| 14 | DQa | 6K | | 50 | DQc | 1H |
| 15 | DQa | 7K | | 51 | $\overline{SBc}$ | 3G |
| 16 | $\overline{SBa}$ | 5L | | 52 | ZQ, NC | 4D |
| 17 | $\overline{K}$, NC | 4L | | 53 | $\overline{SS}$ | 4E |
| 18 | K | 4K | | 54 | $\overline{C}$, NC | 4G |
| 19 | $\overline{G}$ | 4F | | 55 | C, NC | 4H |
| 20 | $\overline{SBb}$ | 5G | | 56 | $\overline{SW}$ | 4M |
| 21 | DQb | 7H | | 57 | $\overline{SBd}$ | 3L |
| 22 | DQb | 6H | | 58 | DQd | 1K |
| 23 | DQb | 7G | | 59 | DQd | 2K |
| 24 | DQb | 6G | | 60 | DQd | 1L |
| 25 | DQb | 6F | | 61 | DQd | 2L |
| 26 | DQb | 7E | | 62 | DQd | 2M |
| 27 | DQb | 6E | | 63 | DQd | 1N |
| 28 | DQb | 7D | | 64 | DQd | 2N |
| 29 | DQb, NC | 6D | | 65 | DQd | 1P |
| 30 | SA | 6A | | 66 | DQd, NC | 2P |
| 31 | SA | 6C | | 67 | SA | 3T |
| 32 | SA | 5C | | 68 | SA | 2R |
| 33 | SA | 5A | | 69 | SA | 4N |
| 34 | NC, $\overline{SE2}$ SA◇ | 6B | | | | |
| 35 | NC, SA* | 5B | | 70 | M1, NC | 3R |

## FIGURE 3.7.8-5
## 32K TO 512K BY 32 & 36 SSRAM IN BGA BOUNDRY SCAN ORDER

**Release 5**




Notes: (1) This standard accommodates synchronous burst address fields ranging from 2 to 6 address b
(2) An 8-word (3 address bits) interleaved burst sequence is currently specified in commercial data sheets

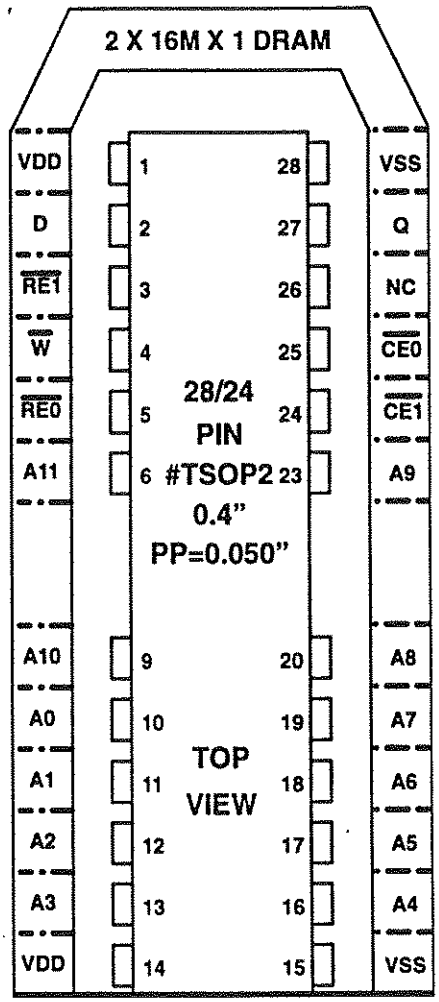
**FIGURE 3.7.8–6**
**16K/32K/64K BY 64 SYNCHRONOUS SRAM WITH BURST COUNTER**

| Burst SRAM Ball Grid Array (BGA) Package Bump Assignments, Top View | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| X72 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| A | DQe | DQe | NC, SA# | SA | SA | $\overline{SS}$, $\overline{SE1}$ | SA | SA | NC, SA$ | DQd | DQd |
| B | DQe | DQe | NC, SA~ | SA | SA | $\overline{G}$ | SA | SA | NC, SA◇ | DQd | DQd |
| C | DQe | DQe | NC, SE2 | VDD, VDDQ | VDD, VDDQ | ND, $\overline{SGW}$ | VDD, VDDQ | VDD, VDDQ | NC, $\overline{SE3}$ | DQd | DQd |
| D | DQe | DQe | VDD, VDDQ | VDD | VSS, VSSQ | $\overline{ADV}$ | VSS, VSSQ | VDD | VDD, VDDQ | DQd | DQD |
| E | DQe, NC | DQf, NC | VDD, VDDQ | VDD | VSS, VSSQ | $\overline{SAC}$ | VSS, VSSQ | VDD | VDD, VDDQ | DQc, NC | DQd, NC |
| F | DQf | DQf | VDD, VDDQ | VDD | VSS, VSSQ | $\overline{SAP}$ | VSS, VSSQ | VDD | VDD, VDDQ | DQc | DQc |
| G | DQf | DQf | VDD, VDDQ | VDD | VSS, VSSQ | VSS, VSSQ | VSS, VSSQ | VDD | VDD, VDDQ | DQc | DQc |
| H | DQf | DQf | VDD, VDDQ | VSS, VSSQ | VSS | VSS | VSS | VSS, VSSQ | VDD, VDDQ | DQc | DQc |
| J | DQf | DQf | $\overline{SWe}$, $\overline{SBe}$ | VSS, VSSQ | VSS | VSS | VSS | VSS, VSSQ | $\overline{SWd}$, $\overline{SBd}$ | DQc | DQc |
| K | $\overline{SWf}$, $\overline{SBf}$ | $\overline{SWg}$, $\overline{SBg}$ | NC, VREF | VSS, VSSQ | VSS | VSS | VSS | VSS, VSSQ | NC, VREF | $\overline{SWb}$, $\overline{SBb}$ | $\overline{SWc}$, $\overline{SBc}$ |
| L | DQg | DQg | $\overline{SWh}$, $\overline{SBh}$ | VSS, VSSQ | VSS | VSS | VSS | VSS, VSSQ | $\overline{SWa}$, $\overline{SBa}$ | DQb | DQb |
| M | DQg | DQg | VDD, VDDQ | VSS, VSSQ | VSS | VSS | VSS | VSS, VSSQ | VDD, VDDQ | DQb | DQb |
| N | DQg | DQg | VDD, VDDQ | VDD | VSS, VSSQ | VSS, VSSQ | VSS, VSSQ | VDD | VDD, VDDQ | DQb | DQb |
| P | DQg | DQg | VDD, VDDQ | VDD | VSS, VSSQ | NC, $\overline{CK}$, K | VSS, VSSQ | VDD | VDD, VDDQ | DQb | DQb |
| R | DQg, NC | DQh, NC | VDD, VDDQ | VDD | VSS, VSSQ | CK, K | VSS, VSSQ | VDD | VDD, VDDQ | DQa, NC | DQb, NC |
| T | DQh | DQh | VDD, VDDQ | VDD | VSS, VSSQ | NC, $\overline{SW}$ | VSS, VSSQ | VDD | VDD, VDDQ | DQa | DQa |
| U | DQh | DQh | $\overline{LBO}$, NC | VDD, VDDQ | VDD, VDDQ | SA1 | VSS, VSSQ | VDD, VDDQ | NC, $\overline{FT}$ | DQa | DQa |
| V | DQh | DQh | NC | SA | SA | SA0 | SA | SA | NC | DQa | DQa |
| W | DQh | DQh | NC, ZQ | NC, TMS | NC, TDI | NC, TCK | NC, TDO | NC, TRST | NC, ZZ | DQa | DQa |

| Address Assignment and Package Dimension Table | | |
|---|---|---|
| **Density** | **Address Assignment** | **Nominal Exterior Package Dimension** |
| 1M (16K X 64, 72) | Basic SA | 21 mm X 25 mm |
| 2M (32K X 64, 74) | ~ | 21 mm X 25 mm |
| 4M (64K X 64, 72) | ~, * | 21 mm X 25 mm |
| 8M (128K X 64, 72) | ~, *, ◇ | TBD |
| 16 M (256K X 64, 72) | ~, *. ◇, # | TBD |

## FIGURE 3.7.8–7
## 16K TO 256K BY 64 & 72 BURST SRAM IN BGA

**Release Release 7**

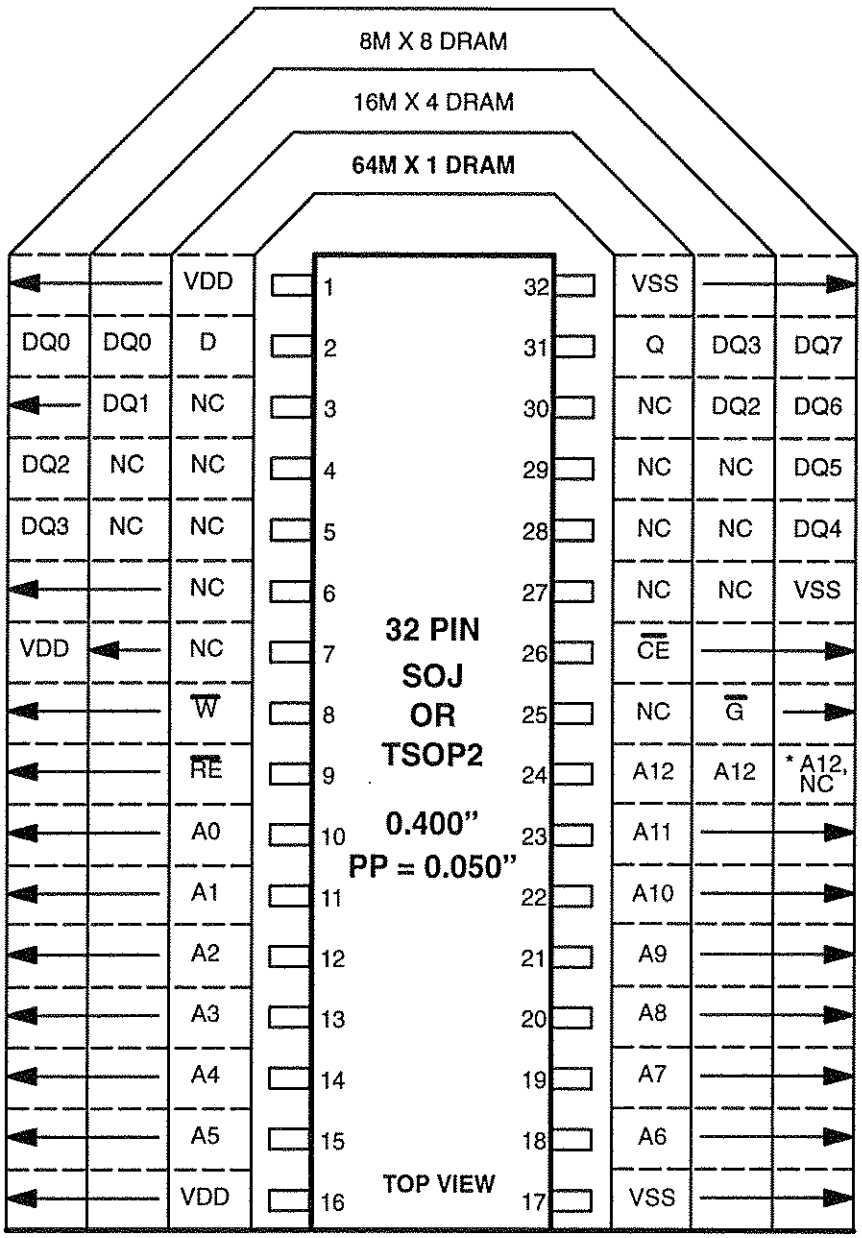



# The JEDEC approved term for this package is PDSO–G

**ROW, REFRESH, & COLUMN ADDRESS CONFIGURATION**

| DEVICE CONFIGURATION | 2 X 16M X 1 | 2 X 16M X 1 |
|---|---|---|
| REFRESH COUNT | 2048 Refresh | 4096 Refresh |
| ROW ADDRESS | A0 → A11 | A0 → A11 |
| REFRESH ADDRESS | A0 → A10 | A0 → A11 |
| COLUMN ADDRESS | A0 → A11 | A0 → A11 |

**FIGURE 3.9.1–11**
**2 X 16M BY 1 DRAM IN TSOP2**




* Pin 24 is NC for the 16M X 4 & 8K X 8 parts with a 4K Refresh.

ROW & COLUMN, ADDRESS CONFIGURATIONS

| DEVICE CONFIGURATION | 64M X 1 | 16M X 4 | 16M X 4 | 8M X 8 | 8M X 8 |
|---|---|---|---|---|---|
| ROW COUNT | | 4K Rows | 8K Rows | 4K Rows | 8K Rows |
| ROW ADDRESSES | A0 ⇒ A12 | A0 ⇒ A11 | A0 ⇒ A12 | A0 ⇒ A11 | A0 ⇒ A12 |
| COLUMN ADDRESSES | A0 ⇒ A12 | A0 ⇒ A11 | A0 ⇒ A10 | A0 ⇒ A10 | A0 ⇒ A9 |

**FIGURE 3.9.1–12**
**64M BY 1 DRAM IN SOJ & TSOP2**

**Release 5r7**

### 3.9.2.1 – 16K & 64K BY 4 DRAM IN DIP

CAPACITY—16K, 64K WORDS OF 4 BITS
LOGIC FEATURES—Multiplexed Address, Common DATA I/O
PACKAGE—18 PIN DIP, 0.3" WIDE
PIN ASSIGNMENT—Fig. 3.9.2–1

### 3.9.2.2 – 16K BY 4 DRAM IN DIP

CAPACITY—16K WORDS OF 4 BITS
LOGIC FEATURES—Multiplexed Address, Separate DATA I/O
PACKAGE—20 PIN DIP, 0.3" WIDE
PIN ASSIGNMENT—Fig. 3.9.2–1
NOTE: At the time that this document was published, this standard was in the process of being rescinded by the Committee.

### 3.9.2.3 – 64K BY 4 DRAM IN RCC

CAPACITY—64K WORDS OF 4 BITS
LOGIC FEATURES—Multiplexed Address with Common DATA I/O
PACKAGE—22 PAD (PIN) RCC, 0.290" X 0.490"
PIN ASSIGNMENT—Fig. 3.9.2–2

### 3.9.2.4 – 256K & 1M BY 4 DRAM FAMILY IN DIP

CAPACITY—256K, 1M WORDS OF 4 BITS
LOGIC FEATURES—Multiplexed Address
PACKAGE—20 PIN DIP, Width: 0.3" for 256K & 1M,
PIN ASSIGNMENT—Fig. 3.9.2–3

### 3.9.2.5 – 256K TO 4M BY 4 DRAM FAMILY IN SOJ & TSOP2

CAPACITY—256K, 1M, 4M WORDS OF 4 BITS
LOGIC FEATURES—Multiplexed Address
PACKAGE—26/20 PIN SOJ: 0.3" by 0.675" for 256K
—26/20 PIN SOJ or TSOP2: 0.3" or 0.35" by 0.675" for 1M
—26/24 PIN SOJ OR TSOP–2: 0.3" for 4M
—28/24 PIN SOJ: 0.4" by 0.725 for 4M
PIN ASSIGNMENT—Fig. 3.9.2–4

### 3.9.2.6 – 64K TO 4M BY 4 DRAM IN ZIP

CAPACITY—64K, 256K, 1M, 4M WORDS OF 4 BITS
LOGIC FEATURES—Multiplexed Address
PACKAGE—20 PIN ZIP, 0.400" WIDE FOR 64K, 256K, & 1M PARTS
—24 PIN ZIP, 0.475" WIDE FOR 4M PART
PIN ASSIGNMENT—Fig. 3.9.2–5

### 3.9.2.7 – 256K & 1M BY 4 DRAM WITH 4 CE IN SOJ & TSOP2

CAPACITY—256K, 1M WORDS OF 4 BITS
LOGIC FEATURES—Multiplexed Address with 4 CE clocks controlling the 4 data bits
PACKAGE—26/24 PIN SOJ, Width: 0.3"
—26/24 PIN TSOP2, WIDTH: 0.3", PIN PITCH: 0.050"
PIN ASSIGNMENT—Fig. 3.9.2–6

### 3.9.2.8 – 256K BY 4 DRAM IN TSOP1

CAPACITY—256K WORDS OF 4 BITS
LOGIC FEATURES—Multiplexed Address
PACKAGE—24/20 PIN TSOP1, 14.4 mm x 6.0 mm, 0.5 mm LEAD PITCH
PIN ASSIGNMENT—Fig. 3.9.2–7

**Release 4**

### 3.9.2.9 – 16M BY 1/4M BY 4 CONFIGURABLE DRAM IN SOJ

CAPACITY—16M WORDS OF 1 BIT or 4M WORDS OF 4 BITS
LOGIC FEATURES—Configurable as a X1 or a X4 part
—The data access mode can be chosen by logic control
PACKAGE—28 PIN SOJ
PIN ASSIGNMENT—Fig. 3.9.2–8

### 3.9.2.10 – 256K TO 4M BY 4 NON–MUX DRAM FAMILY IN SOJ

CAPACITY—256K, 1M, 4M WORDS OF 4 BITS
LOGIC FEATURES—Non–Multiplexed Address
PACKAGE—28, 32, OR 34 PIN SOJ, WIDTH Not yet defined
PIN ASSIGNMENT—Fig. 3.9.2–9

### 3.9.2.11 – 4M BY 4 DRAM WITH 1 $\overline{CE}$ AND 4 $\overline{CE}$ IN TSOP2

CAPACITY—4M WORDS OF 4 BITS
LOGIC FEATURES—Multiplexed Address
—There are two versions of this part, one with 1 $\overline{CE}$ and one with 4 $\overline{CE}$ controlling each of the data bits
PACKAGE—28/24 PIN TSOP2, 0.4" WIDE FOR THE 1 $\overline{CE}$ PART
— 28 PIN TSOP2, 0.4" WIDE FOR THE 4 $\overline{CE}$ PART
PIN ASSIGNMENT—Fig. 3.9.2–10

### 3.9.2.12 – 16M BY 4 DRAM IN SOJ & TSOP2

CAPACITY—16M WORDS OF 4 BITS
LOGIC FEATURES—Multiplexed Address
This part is available in two package sizes as defined below. The pin rotations of the two are essentially the same with the exception of two NC pins.
PACKAGE—34 PIN SOJ, WIDTH: 0.5"
—34PIN TSOP2, WIDTH: 0.5", PIN PITCH: 0.050"
PIN ASSIGNMENT—Fig. 3.9.2–11
PACKAGE—32 PIN SOJ, 0.400" Wide
—32 PIN TSOP2, 0.400" WIDE, 0.050" PP.
PIN ASSIGNMENT—Fig. 3.9.1–12

### 3.9.2.13 – 1M, 2M, & 4M BY 2 DRAM IN SOJ & TSOP2

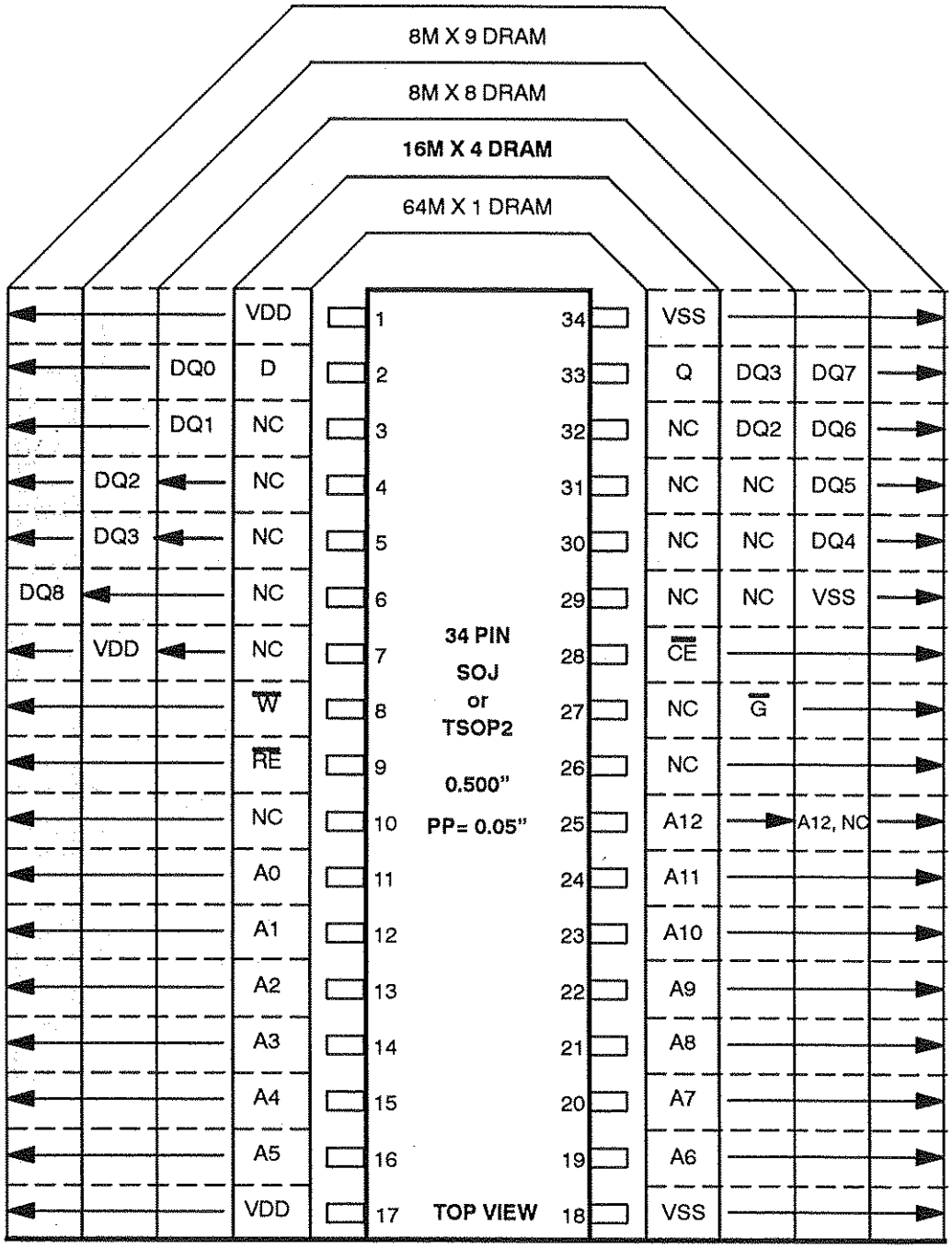
CAPACITY—1M, 2M, & 4M WORDS OF 2 BITS
LOGIC FEATURES—Multiplexed Address and a separate $\overline{CE}$ control for each data bit.
PACKAGE—26/20, 26/24, & 28/24 PIN SOJ or TSOP2, WIDTH: 0.3", PIN PITCH: 0.050"
PIN ASSIGNMENT—Fig. 3.9.2–12

### 3.9.2.14 – 16M BY 4 DRAM WITH 4 $\overline{CE}$ IN SOJ OR TSOP2

CAPACITY—16M WORDS OF 4 BITS
LOGIC FEATURES—Multiplexed Address
—The part, has 4 $\overline{CE}$, one controlling each of the data bits.
PACKAGE— 34 PIN TSOP2, 12.7 mm WIDE, PP = 1.27 mm
— 34 PIN SOJ, 12.7 mm WIDE, PP = 1.27 mm
PIN ASSIGNMENT—Fig. 3.9.2–14
PACKAGE—32 PIN SOJ, 10.16 mm Wide
—32 PIN TSOP2, 10.16 mm Wide, 1.27 mm PP
PIN ASSIGNMENT—Fig. 3.9.2–14

### 3.9.2.15 – 64M X 4 DRAM IN TSOP2 PIN ROTATION

CAPACITY— 64M WORDS OF 4 BITS
LOGIC FEATURES—Multiplexed Address, Common DATA I/O
PACKAGE—TSOP2, PIN COUNT AND DIMENSIONS NOT DEFINED
PIN ASSIGNMENT—Fig. 3.9.2–15
**NOTE: This standard defines a pin rotation only. The package details, dimension and pin count, are not defined at this time.**



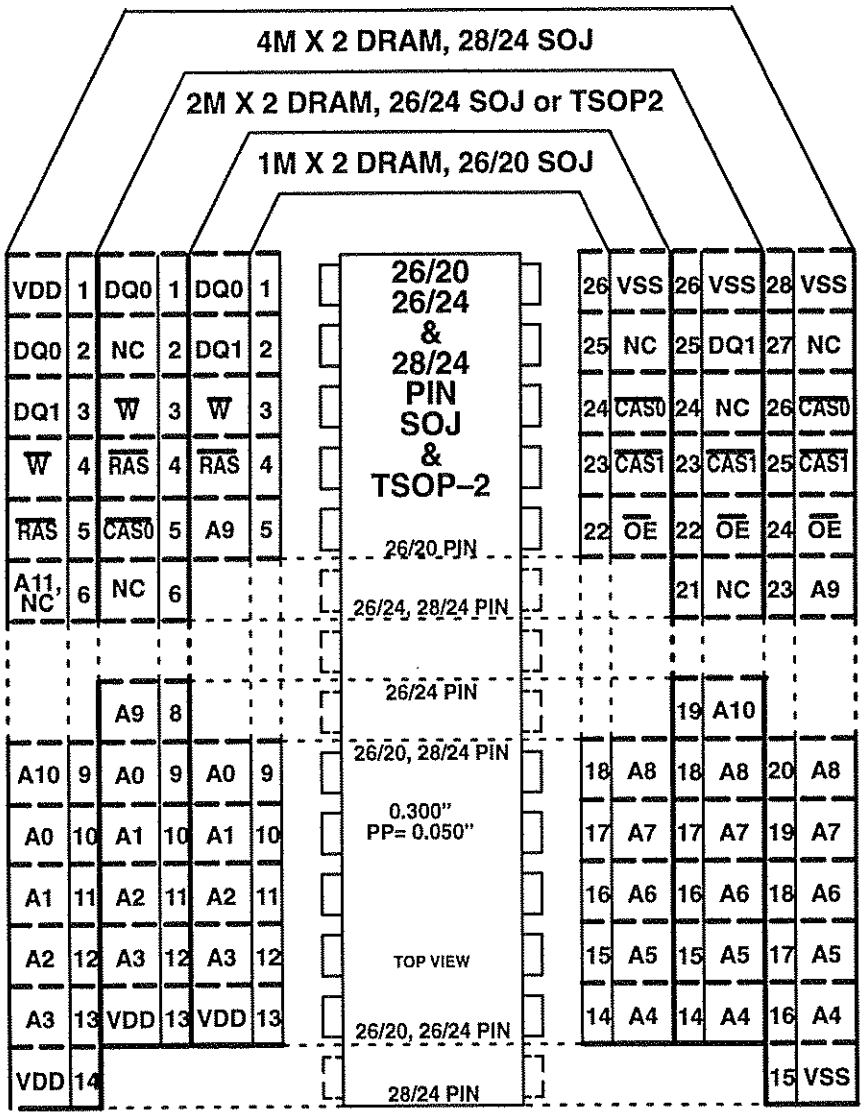

ROW, COLUMN, & REFRESH ADDRESS CONFIGURATIONS

| DEVICE CONFIGURATION<br>REFRESH COUNT | 64M X 1 | 16M X 4 | 8M X 8(9)<br>4K Refresh | 8M X 8(9)<br>8K Refresh |
|---|---|---|---|---|
| ROW/REFRESH ADDRESSES | A0 Through A12 | A0 Through A12 | A0 Through A11 | A0 Through A12 |
| COLUMN ADDRESSES | A0 Through A12 | A0 Through A10 | A0 Through A10 | A0 Through A9 |

▌This standard recognizes that some early deliveries of these parts may have to be in a 0.6" wide package

## FIGURE 3.9.2-11
## 16M BY 4 DRAM IN SOJ & TSOP2

**Release 4 a**

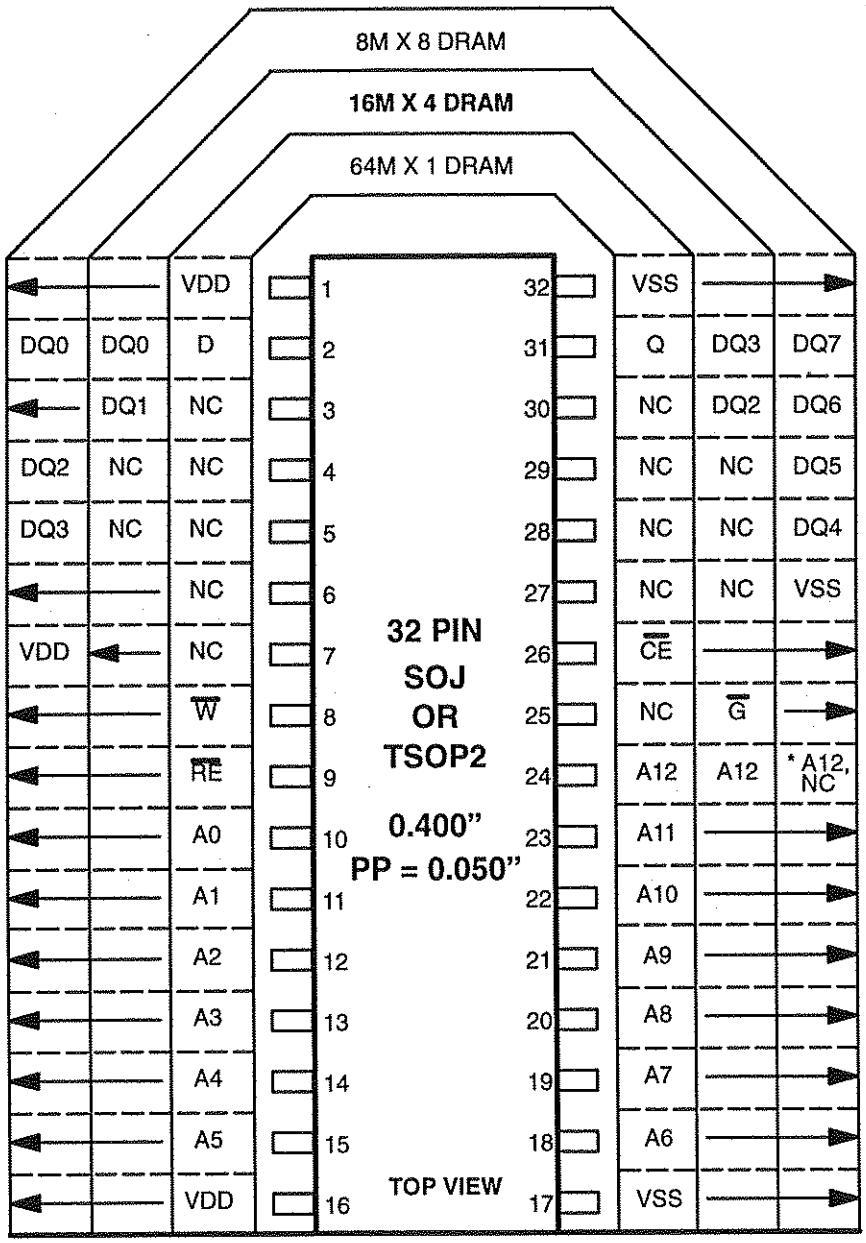



ROW, & COLUMN, ADDRESS CONFIGURATION

| DEVICE CONFIGURATION | 1M X 2 | 2M X 2 | 4M X 2 | 4M X 2 |
|---|---|---|---|---|
| ROW COUNT | 1K Rows | 1K Rows | 2K Rows | 4K Rows |
| ROW ADDRESSES | A0 → A9 | A0 → A10 | A0 → A10 | A0 → A11 |
| COLUMN ADDRESS | A0 → A9 | AO → A9 | A0 → A10 | A0 → A9 |

## FIGURE 3.9.2–12
## 1M TO 4M BY 2 DRAM WITH 2 CAS IN SOJ & TSOP2

Release 4r7

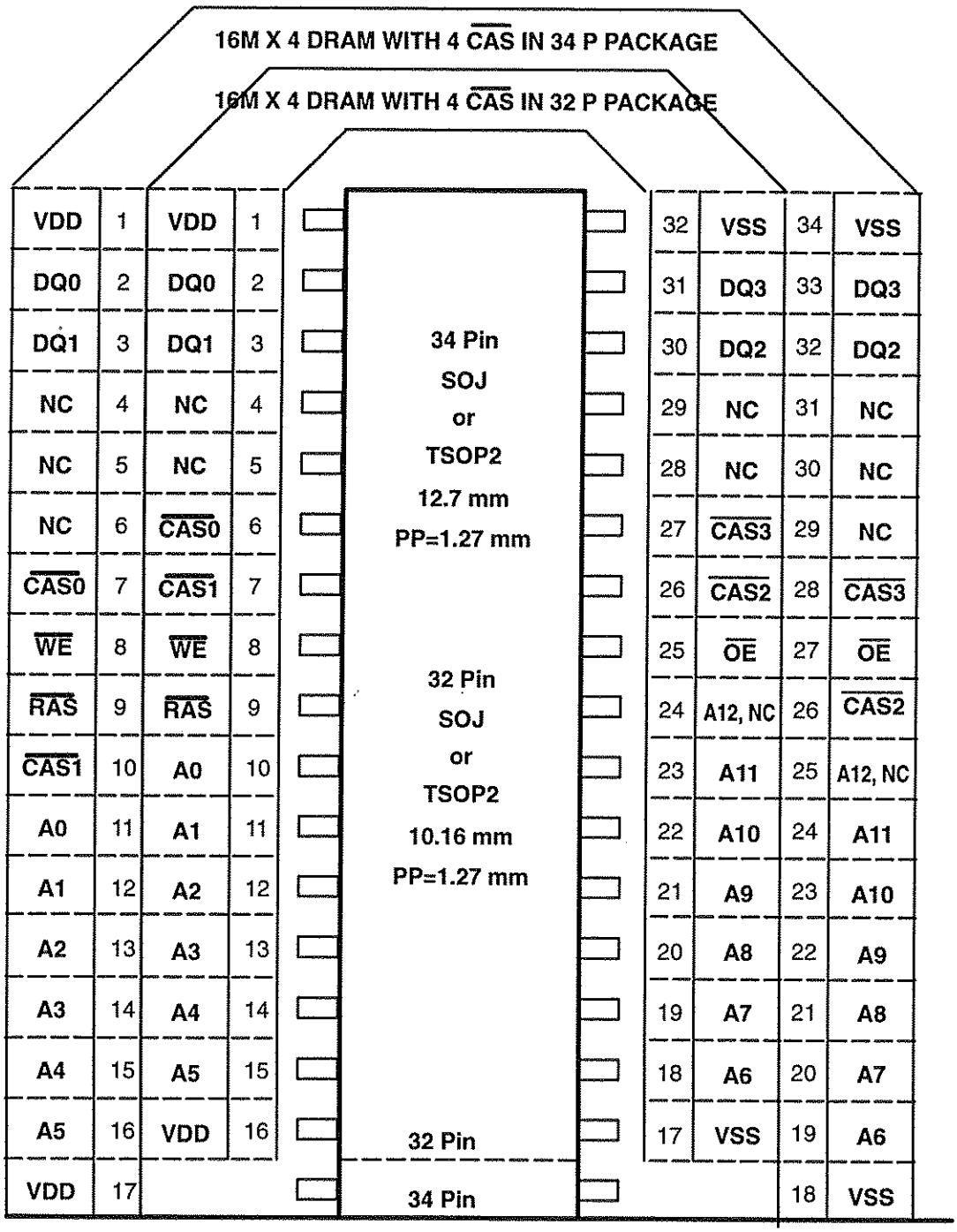



* Pin 24 is NC for the 16M X 4 & 8K X 8 parts with a 4K Refresh.

ROW & COLUMN, ADDRESS CONFIGURATIONS

| DEVICE CONFIGURATION | 64M X 1 | 16M X 4 | 16M X 4 | 8M X 8 | 8M X 8 |
|---|---|---|---|---|---|
| ROW COUNT | | 4K Rows | 8K Rows | 4K Rows | 8K Rows |
| ROW ADDRESSES | A0 ⇒ A12 | A0 ⇒ A11 | A0 ⇒ A12 | A0 ⇒ A11 | A0 ⇒ A12 |
| COLUMN ADDRESSES | A0 ⇒ A12 | A0 ⇒ A11 | A0 ⇒ A10 | A0 ⇒ A10 | A0 ⇒ A9 |

## FIGURE 3.9.2–13
## 16M BY 4 DRAM IN SOJ & TSOP2

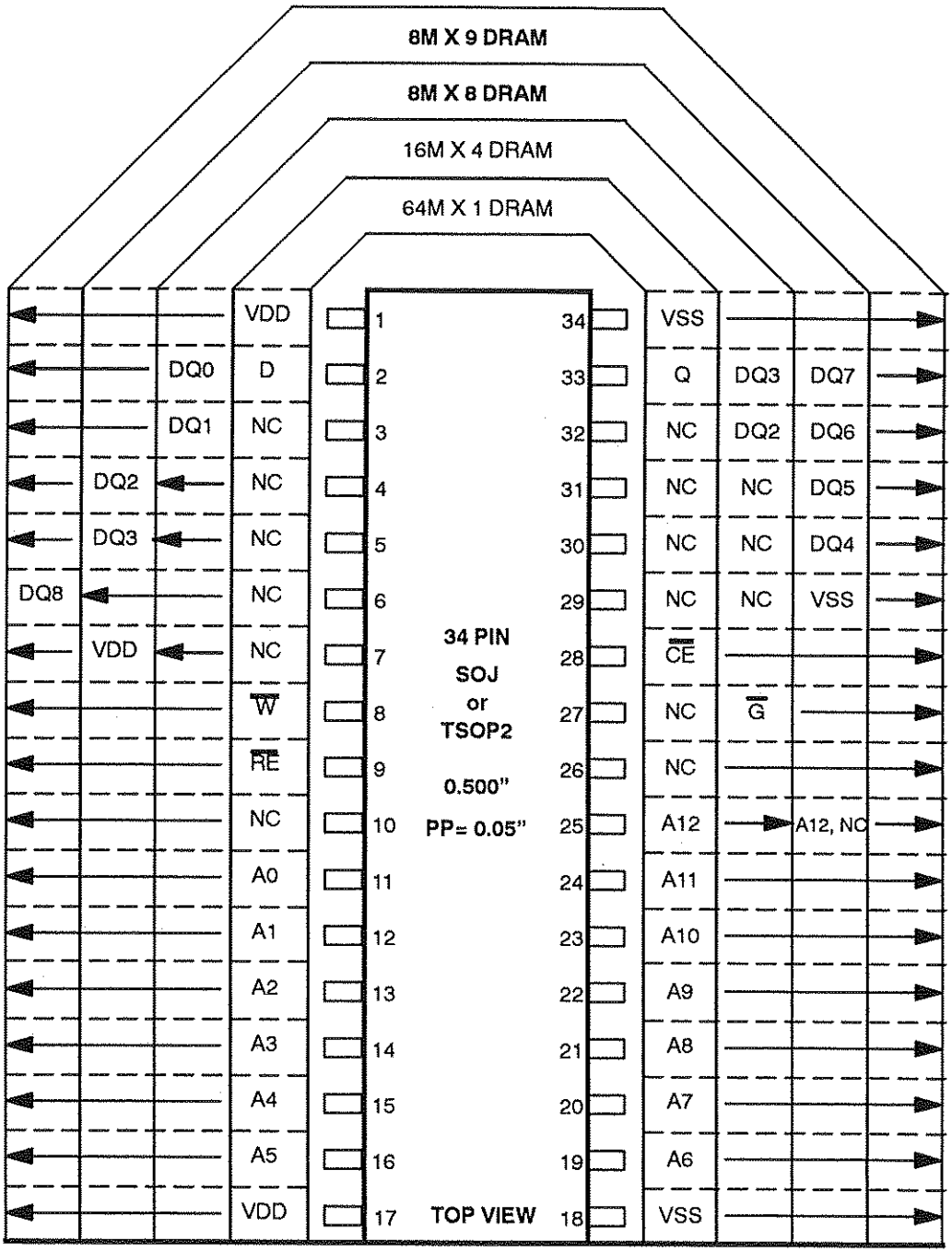



| ADDRESS CONFIGURATIONS | | |
|---|---|---|
| ROW COUNT | 4K Rows | 8K Rows |
| ROW ADDRESSES | A0 ⇒ A11 | A0 ⇒ 12 |
| COLUMN ADDRESSES | A0 ⇒ A11 | A0 ⇒ 10 |

*NOTE: The JESD30 approved term for the TSOP2 package is PDSO–G, for the SOJ is PDSO–J

## FIGURE 3.9.2–14
## 16M BY 4 DRAM WITH 4 CAS IN SOJ & TSOP2

Release 6r7




ROW, COLUMN, & REFRESH ADDRESS CONFIGURATIONS

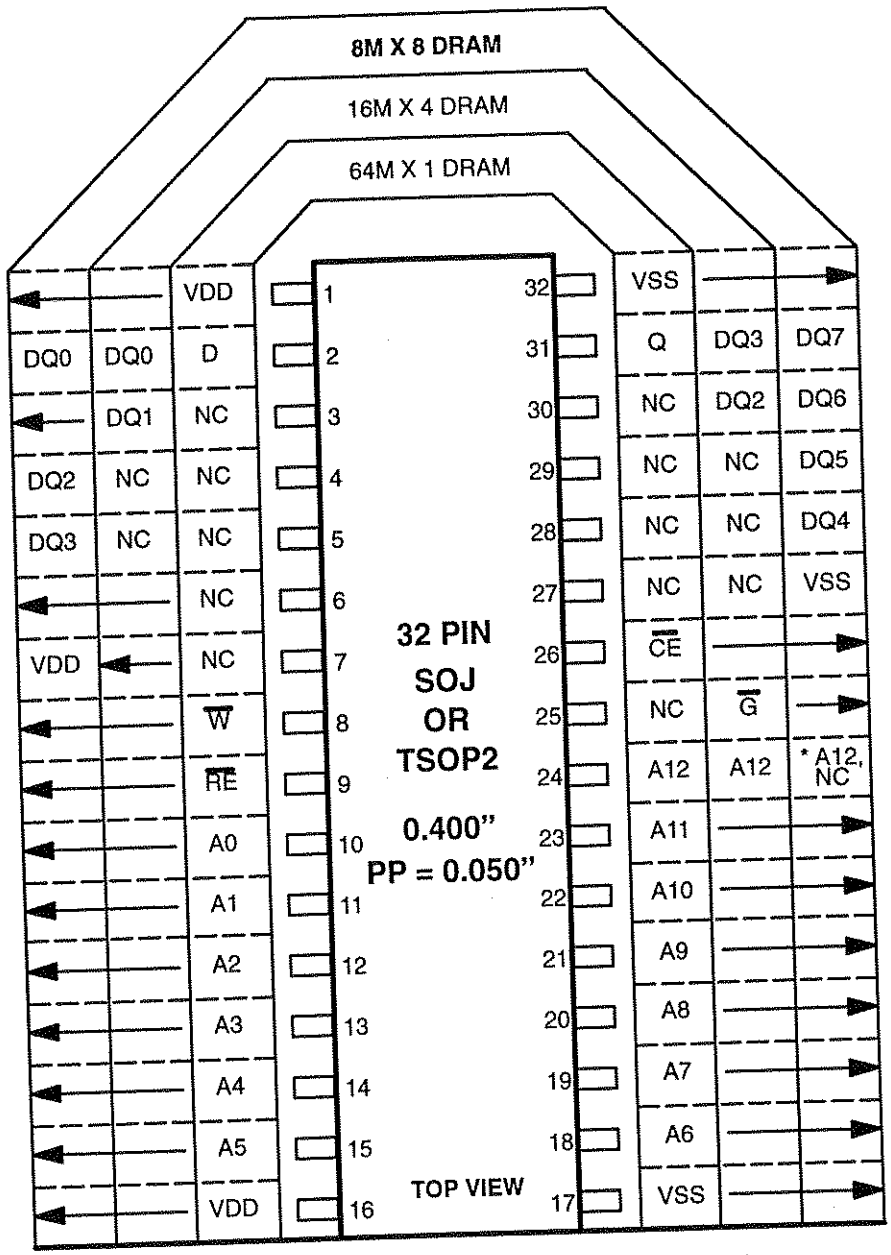
| DEVICE CONFIGURATION<br>REFRESH COUNT | 64M X 1 | 16M X 4 | 8M X 8(9)<br>4K Refresh | 8M X 8(9)<br>8K Refresh |
|---|---|---|---|---|
| ROW/REFRESH ADDRESSES | A0 Through A12 | A0 Through A12 | A0 Through A11 | A0 Through A12 |
| COLUMN ADDRESSES | A0 Through A12 | A0 Through A10 | A0 Through A10 | A0 Through A9 |

This standard recognizes that some early deliveries of these parts may have to be in a 0.6" wide package

## FIGURE 3.9.3-7

## 8M BY 8 & 9 DRAM IN SOJ & TSOP2

**Release 4 a**




* Pin 24 is NC for the 16M X 4 & 8K X 8 parts with a 4K Refresh.

ROW & COLUMN, ADDRESS CONFIGURATIONS

| DEVICE CONFIGURATION | 64M X 1 | 16M X 4 4K Rows | 16M X 4 8K Rows | 8M X 8 4K Rows | 8M X 8 8K Rows |
|---|---|---|---|---|---|
| ROW COUNT | | | | | |
| ROW ADDRESSES | A0 ⇒ A12 | A0 ⇒ A11 | A0 ⇒ A12 | A0 ⇒ A11 | A0 ⇒ A12 |
| COLUMN ADDRESSES | A0 ⇒ A12 | A0 ⇒ A11 | A0 ⇒ A10 | A0 ⇒ A10 | A0 ⇒ A9 |

**FIGURE 3.9.3–8**

**8M BY 8 DRAM IN SOJ & TSOP2**

**3.9.4.1 – 64K BY 16 DRAM WITH 2 $\overline{W}$ IN SOJ & TSOP2**

CAPACITY—64K WORDS OF 16 BITS,
LOGIC FEATURES—MULTIPLEXED ADDRESS
PACKAGE—40 PIN SOJ, 0.400" WIDE
—44/40 PIN TSOP2, 0.400" WIDE, 0.8mm PIN PITCH
PIN ASSIGNMENT—Fig. 3.9.4–1 (SOJ)
—Fig. 3.9.4–6 (TSOP2)

**3.9.4.2 – 256K & 1M BY 16 & 18 WITH 2 $\overline{CE}$ OR 2 $\overline{W}$ DRAM IN SOJ & TSOP2**

CAPACITY—256K, 1M WORDS OF 16 & 18 BITS,
The standard for the 2 $\overline{W}$ versions of the 1M part has been rescinded and removed from Figs. 3.9.4–4 & 3.9.4–5 in Release 5.
LOGIC FEATURES—MULTIPLEXED ADDRESS
—There are two versions of these parts, one with 2 $\overline{W}$ and the other with 2 $\overline{CE}$.
—The two clocks control the LOWER BYTE and UPPER BYTE data bits.
—The 1M part allows the option of the manufacturer to utilize either 1K or 4K refresh cycles
PACKAGE—256K in 40 PIN SOJ, 0.400" WIDE
—256K in 44/40 PIN TSOP2, 0.400" WIDE, 0.8 mm PIN PITCH
—1M IN 42 PIN SOJ, 0.400" WIDE
—1M in 50/44 PIN TSOP2, 0.400" WIDE, 0.8 mm PIN PITCH
PIN ASSIGNMENT—Fig. 3.9.4–2 (256K SOJ)
—Fig. 3.9.4–3 (256K TSOP2)
—Fig. 3.9.4–4 (1M SOJ)
—Fig. 3.9.4–5 (1M TSOP2)

**3.9.4.3 – 256K BY 16 DRAM WITH EXTENDED FUNCTIONS IN DIP AND SOJ**

CAPACITY—256K WORDS OF 16 BITS
LOGIC FEATURES—This part contains multiple logic functions that are similar to those used in MPDRAMS and that are keyed for VIDEO memory applications. All devices meeting this standard must contain all functions which must be implemented as defined in the TRUTH TABLE.
PACKAGE—40 PIN DIP, 0.400" WIDE, 0.100" PIN PITCH
—40 PIN SOJ, 0.400" WIDE, 0.050" PIN PITCH
PIN ASSIGNMENT—Fig. 3.9.4–7A
FUNCTION TRUTH TABLE—Fig. 3.9.4–7B

**3.9.4.4 – 2M BY 16 & 4M BY 16 & 18 DRAM IN TSOP2**

CAPACITY—2M & 4M WORDS OF 16 or 4M WORDS OF18 BITS
LOGIC FEATURES—MULTIPLEXED ADDRESS
—These parts utilizes 4K or 8K refresh cycles
PACKAGE—50 PIN TSOP2, 0.400" WIDE, 0.8 mm PIN PITCH, X16 parts only
PACKAGE—54 PIN TSOP2, 0.500" WIDE, 0.8 mm PIN PITCH
PIN ASSIGNMENT—Fig. 3.9.4–8

**3.9.4.5 – 128K & 256K BY 16 BURST DRAM WITH 2 CAS IN SOJ, TSOP2, OR ZIP**

CAPACITY—128K OR 256K WORDS OF 16 BITS
LOGIC FEATURES—MULTIPLEXED ADDRESS
—These parts have BURST data out capability
PACKAGE—40 PIN SOJ, 10.16 mm WIDE, 1.27 mm PIN PITCH
PACKAGE—44/40 PIN TSOP2, 10.16 mm WIDE, 0.8 mm PIN PITCH
PACKAGE—40 PIN ZIP, 1.27 mm PIN PITCH (256K only)
PIN ASSIGNMENT—SOJ, Fig. 3.9.4–9
PIN ASSIGNMENT—TSOP2, Fig. 3.9.4–10
PIN ASSIGNMENT—ZIP, Fig. 3.9.4–11, (256K ONLY)

### 3.9.4.6 – 16M X 16 DRAM IN TSOP2 PIN ROTATION

CAPACITY— 16M WORDS OF 16 BITS
LOGIC FEATURES—Multiplexed Address, Common DATA I/O
PACKAGE—TSOP2, PIN COUNT AND DIMENSIONS NOT DEFINED
PIN ASSIGNMENT—Fig. 3.9.4–12
**NOTE: This standard defines a pin rotation only. The package details, dimension and pin count, are not defined at this time.**

### 3.9.4.7 – 128K AND 256K BY 32 DRAM WITH 4 $\overline{CE}$ IN SSOP

CAPACITY—128K OR 256K WORDS OF 32 BITS
LOGIC FEATURES—Multiplexed Address
—The part, has 4 $\overline{CE}$, one controlling each group of 8 data bits.
PACKAGE— 64 PIN SSOP, 0.525" WIDE, PP = 0.8 mm
PIN ASSIGNMENT—Fig. 3.9.4–13

### 3.9.4.8 – 512K & 2M BY 32 & 36 DRAM WITH 4 $\overline{CE}$ IN SOJ & TSOP2

CAPACITY—512K, 2M WORDS OF 32 & 36 BITS,
LOGIC FEATURES—MULTIPLEXED ADDRESS
—The part, has 4 $\overline{CE}$, one controlling each group of 8 or 9 data bits.
—The standard allows the option of the manufacturer to utilize either 1K or 4K refresh cycles
PACKAGE—70 PIN TSOP2, 10.16 mm WIDE, 0.8 mm PP
—70 PIN TSOP2, 10.16 mm WIDE, 0.65 mm PP, 512K only.
—70 PIN SOJ, 10.16 mm WIDE, 0.8 mm PP
PIN ASSIGNMENT—Fig. 3.9.4–14

### 3.9.4.9 – 8M X 32 DRAM IN TSOP2 PIN ROTATION

CAPACITY— 8M WORDS OF 32 BITS
LOGIC FEATURES—Multiplexed Address, Common DATA I/O
PACKAGE—TSOP2, PIN COUNT AND DIMENSIONS NOT DEFINED
PIN ASSIGNMENT—Fig. 3.9.4–15
**NOTE: This standard defines a pin rotation only. The package details, dimension and pin count, are not defined at this time.**

### 3.9.4.10 – 2M X 32 DRAM IN TSOP2

CAPACITY— 8M WORDS OF 32 BITS
LOGIC FEATURES—Multiplexed Address, Common DATA I/O
PACKAGE—86 PIN TSOP2, 10.16 mm WIDE, 0.5 mm PP
PIN ASSIGNMENT—Fig. 3.9.4–16

MANDATORY TRUTH TABLE FOR 256K BY 16 DRAM with EXTENDED FUNCTIONS

| Mnem. | Function | Valid at RE | | | | | Valid at CE |
|---|---|---|---|---|---|---|---|
| | | CE | G | W | DSF(1) | *DSF2 | DSF(1) |
| RW | READ/WRITE | 1 | 1 | 1 | 0 | 0 | 0 |
| BW | BLOCK WRITE | 1 | 1 | 1 | 0 | 0 | 1 |
| LMR | LOAD MASK REGISTER | 1 | 1 | 1 | 1 | 0 | 0 |
| LCR | LOAD COLOR REGISTER | 1 | 1 | 1 | 1 | 0 | 1 |
| RWM | WRITE, MASKED | 1 | 1 | 0 | 0 | 0 | 0 |
| BWM | BLOCK WRITE, MASKED | 1 | 1 | 0 | 0 | 0 | 1 |
| CBR | CBR REFRESH (1) | 0 | X | 1 | 0 | 0 | X |
| CBRN | CBR REFRESH (2) | 0 | X | 1 | 1 | 0 | X |
| FWT | FLASH WRITE | 1 | 1 | 0 | 1 | 0 | X |

* IF DSF2 IS PRESENT

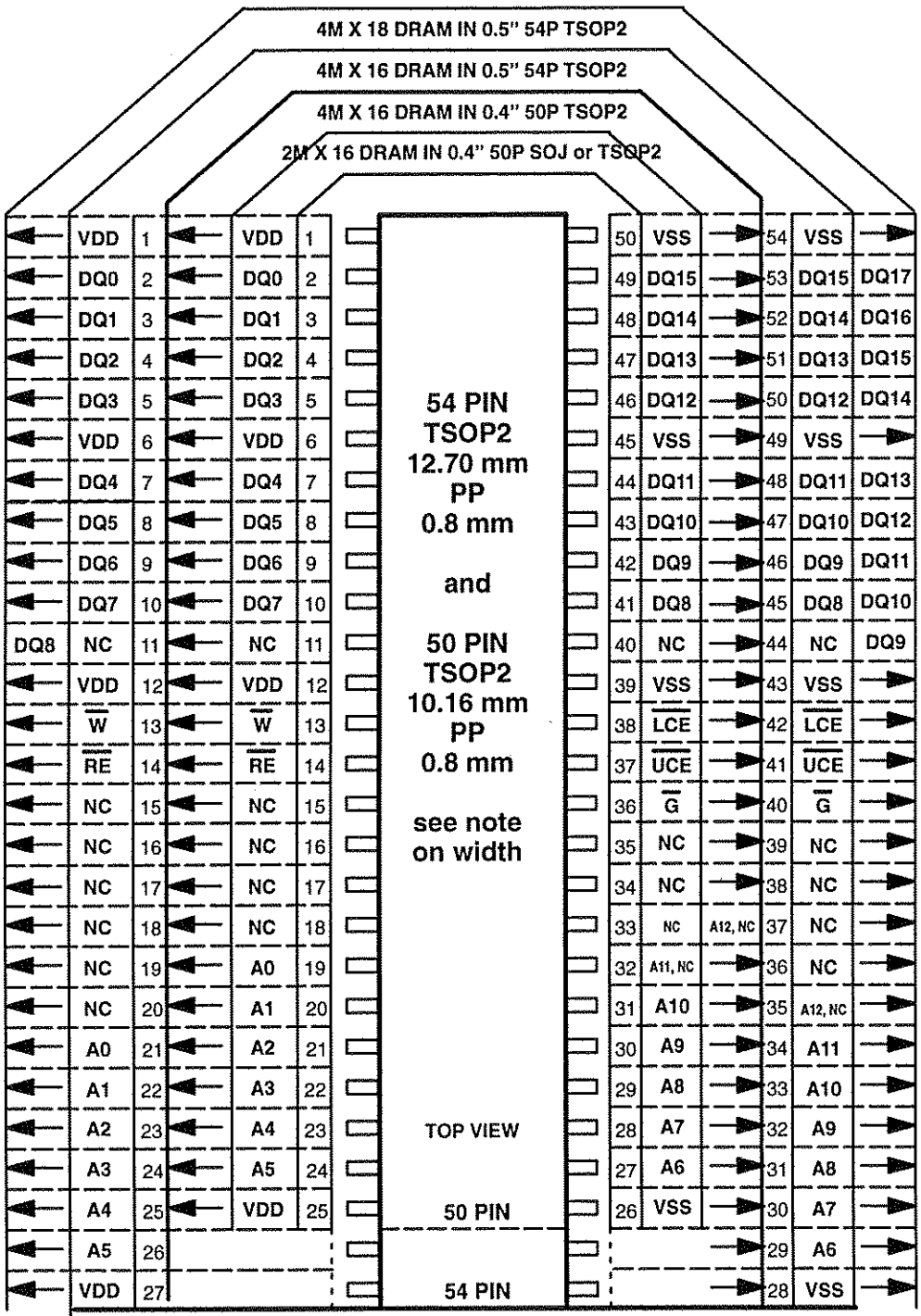
CBR(1) – All optional modes reset

CBR(2) – Any optional modes remain active

**FIGURE 3.9.4–7 B**

**256K BY 16 DRAM MANDATORY EXTENDED FUNCTION TRUTH TABLE**

**Release 4**




**54 P ADDRESS CONFIGURATION**

| | 4K ROWS | 8K ROWS |
|---|---|---|
| 4M X 16/18 | | |
| ROW ADDRESSES | A0 → A11 | A0 → A12 |
| COLUMN ADDRESSES | A0 → A9 | A0 → A8 |

**50 P ADDRESS CONFIGURATION**

| | 2K ROWS | 4K ROWS | 8K ROWS |
|---|---|---|---|
| 2M X 16 | | | |
| ROW ADDRESS | A0 ⇒ A10 | A0 ⇒ A11 | |
| COLUMN ADDRESS | A0 ⇒ A9 | A0 ⇒ A8 | |
| 4M X 16 | 2K ROWS | 4K ROWS | 8K ROWS |
| ROW ADDRESS | A0 ⇒ A10 | A0 ⇒ A11 | A0 ⇒ A12 |
| COLUMN ADDRESS | A0 ⇒ A10 | A0 ⇒ A9 | A0 ⇒ A8 |

* NOTES:
For 54P parts, Pin 35 is A12 for 8K rows and NC for 4K rows.

For 50P 4M parts, Pin 33 is A12 for 8K rows and NC for 4K rows. Pin 32 is NC for devices with 11 row & 11 columns and A11 for other Refresh/Address options..

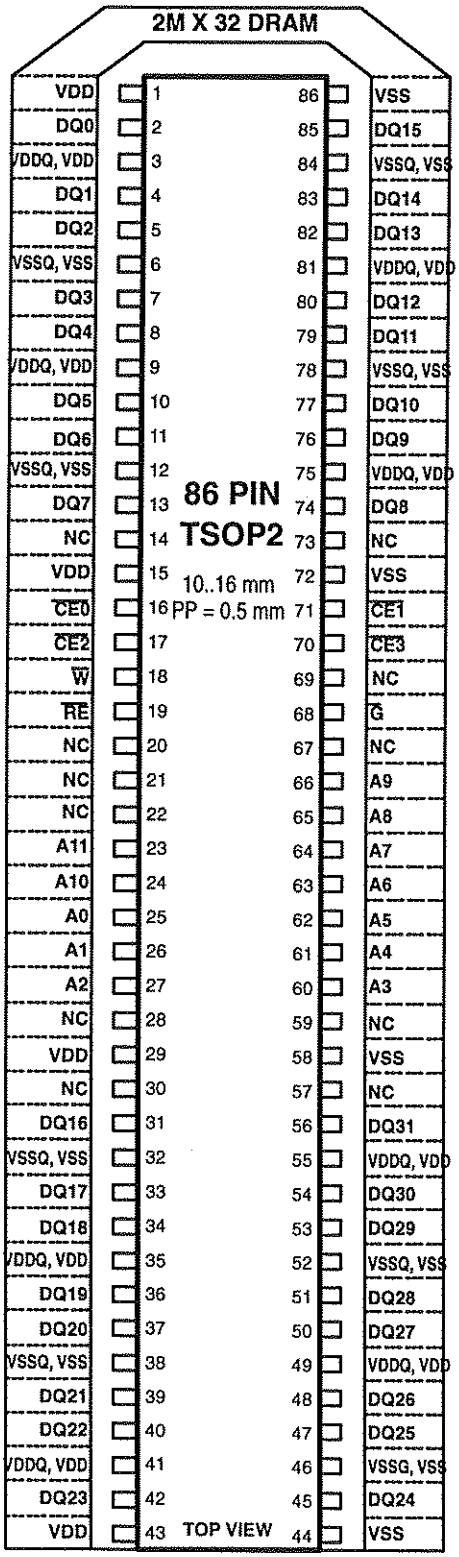
For 50P 2M parts, Pin 32 is A11 for devices with 4K rows and NC for devices with 2K rows.

The use of CBR for Refresh is strongly recommended for these devices.

* NOTE: The JEDEC Std. 30 term for the TSOP–2 package is PDSO–G.

This standard recognizes that some early deliveries of the 54P parts may have to be in a 0.6"wide package

## FIGURE 3.9.4–8
## 2M BY 16 & 4M BY 16 & 18 DRAM IN TSOP–2




NOTES
1. The standard refresh period is 64 ms.
2. The VDDQ designator is used when the power supply pins for the DQ I/O drivers are internally DC isolated from the VDD power supply pins.
3. The VSSQ designator is used when the ground reference pins

The JEDEC Std. No. 30 designator for the TSOP2 package is PDSO–G

| Configuration | 2M X 32 |
|---|---|
| ROW COUNT | 4K Rows |
| ROW ADDRESS | A0 ⇒ A11 |
| COLUMN ADDRESS | A0 ⇒ A8 |

**FIGURE 3.9.4–16**
**2M BY 32 DRAM IN TSOP2**

### 3.9.5.1 – OPTIONAL OPERATIONAL MODES AND CYCLES FOR DRAM

The definitions for serial data access, bit write, and refresh control included in Release 1 of this standard have been replaced by the more general definitions of Optional Operational Modes and Cycles beginning on page 3.9.5–11

### 3.9.5.2 – 1M DRAM BUILT IN TEST FUNCTION

An approved option for 1M DRAM (1M X 1 or 256K X 4) is the inclusion of a built in manufacturer defined "Test Mode". This mode is enabled using a dedicated pin which is optional NC or TF. When the optional mode is implemented, the manufacturer should include notes on his data sheet as follows:

(A) Normal operation requires the "TF" pin be connected to a VSS or logic low level or left unconnected.

(B) When the "TF" pin is connected to the manufacturer defined positive voltage, the internal test mode will be actuated. Contact the manufacturer for specific operational details of the Test Mode.

### 3.9.5.3 – ON–CHIP REFRESH CONTROL FOR X8 DRAM

This standard describes an optional feature that is applicable to the non–address multiplexed byte wide dynamic RAMs described in this publication. The standard establishes the clock timing sequence needed to invoke an on–chip refresh feature.

### 3.9.5.4 – $\overline{G}$ BEFORE $\overline{E}$ REFRESH

If G is low when E falls, a refresh cycle is executed. During this type of refresh cycle, an internal counter/register provides the refresh address and the external address is ignored

### 3.9.5.5 – DRAM SPECIAL TEST AND OPERATIONAL MODES

This standard defines a scheme for controlling a series of special operational modes for address multiplexed DRAM. The standard defines the logic interface required to enter, control and exit from the special modes. In addition, it defines a basic test mode plus a series of other special test and operational modes. The details of this standard are given on pages 3.9.5–7 through 3.9.5–10.

### 3.9.5.6 – NON–MULTIPLEXED DRAM OPERATION

This standard defines multiple aspects of the address and clock relationships for DRAMs that have a non–multiplexed address architecture. It also defines the relationships between the address bits of multiplexed and non–multiplexed devices. The details of the standard are given on page 3.9.5–13

### 3.9.5.7 – DRAM EXTENDED DATA OUT

This standard defines the output characteristics of Extended Data Out (EDO) feature for DRAMs. Any part encorporating "EDO" must satisfy all of the following criteria to conform to the Standard. The details of the EDO standard are given on P 3.9.5–14

### 3.9.5.8 – 256M DRAM TEST MODE DATA AND ADDRESS COMPRESSION

This standard defines the algorithms for data and address compression when 256M DRAMs are operated in the built in special test mode. The detaild of the Compression standard are given on P 3.9.5–15

### 3.9.5.9 – PIPELINED NIBBLE MODE DEFINITION

This standard defines the output characteristics of the Pipelined Nibble Mode feature for DRAMs. Any part encorporating Pipelined Nibble Mode must satisfy all of the following criteria to conform to the Standard. The details of the standard are given on P 3.9.5–16

**Release 7**

## Pipelined Nibble Mode Definition

Devices that operate in the Pipelined Nibble Mode are required to meet the following criteria to conform to this Standard.

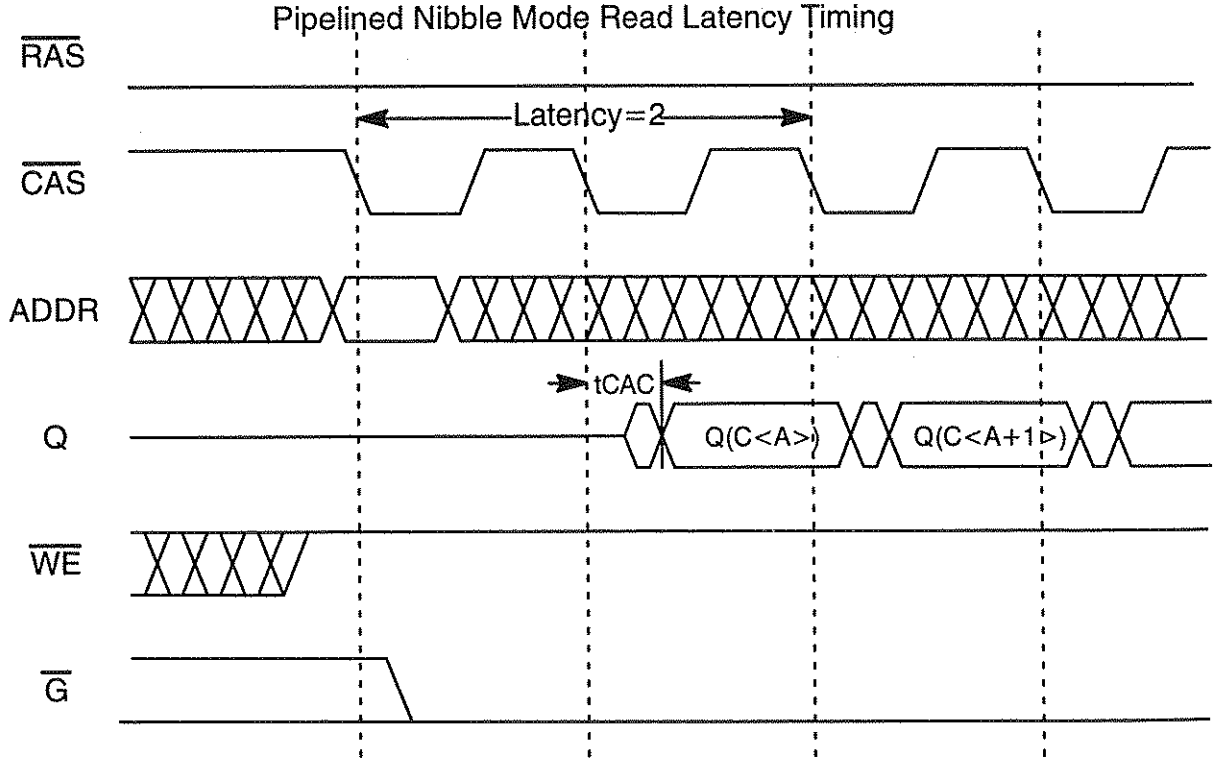
1. Burst Length shall be 4
2. Read Latency shall be 2 (refer to attached timing diagram for clarification)
3. Write Latency shall be 0
4. A WCBR, with the address keys shown below, is used to program the burst sequence. It is persistant until it is reprogrammed.

| Address Sequence | A0 | A1 | A2 | A3 | A4 | A5 | A6 | A7 |
|---|---|---|---|---|---|---|---|---|
| Linear | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Interleaved | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

5. $\overline{WE}$ transition during $\overline{CAS}$ precharge time causes burst to terminate
6. $\overline{WE}$ transition during $\overline{CAS}$ low, which remains through the $\overline{CAS}$ rising edge, causes burst to terminate.
7. $\overline{WE}$ pulse which is fully enclosed by a $\overline{CAS}$ low will be ignored and not cause a burst terminate.
8. Same output enable function as in EDO definition.
9. Read–modify–write cycle within $\overline{CAS}$ active cycle is not supported.
10. A Pipelined Nibble Mode device may not be reconfigured by the user to operate in the standard EDO (non–burst) mode.

**FOR REFERENCE ONLY**

Pipelined Nibble Mode Read Latency Timing



## 256M DRAM Address Compression for Test–Mode

| Devices | | 16K Refresh cycles (RA0–RA13) | | | 8K Refresh cycles (RA0–RA12) | | |
|---|---|---|---|---|---|---|---|
| | | Normal Mode Input Addr. | Test Mode | | Normal Mode Input Addr. | Test Mode | |
| | | | Input Address | Compress. Address | | Input Address | Compress. Address |
| 256M | 64M X 4 | RA0–RA13 CA0–CA11 | RA0–RA13 CA0–CA7 | CA8–11 | RA0–RA12 CA0–CA12 | RA0–RA12 CA0–CA8 | CA9–12 |
| | 32M X 8 | RA0–RA13 CA0–CA11 | RA0–RA13 CA0–CA7 | CA8–10 | RA0–RA12 CA0–CA11 | RA0–RA12 CA0–CA8 | CA9–11 |
| | 16M X 16 | RA0–RA13 CA0–CA9 | RA0–RA13 CA0–CA7 | CA8–9 | RA0–RA12 CA0–CA10 | RA0–RA12 CA0–CA8 | CA9–10 |
| | 8M X 32 | RA0–RA13 CA0–CA8 | RA0–RA13 CA0–CA7 | CA8 | RA0–RA12 CA0–CA9 | RA0–RA12 CA0–CA8 | CA9 |

## 256M DRAM Data Space Compression for Test–Mode

When the memory device is operating in the compression mode, the data space is compressed with four DQn circuits supplying test data and receiving test results as defined in the following table.

| Devices | | Normal Mode Data Interface | Test Mode Data Interface | |
|---|---|---|---|---|
| | | | Active Data Bits | Data Bits Served |
| 256M | 64M X 4 | DQ0–DQ3 | DQ0 | DQ0 |
| | | | DQ1 | DQ1 |
| | | | DQ2 | DQ2 |
| | | | DQ3 | DQ3 |
| | 32M X 8 | DQ0–DQ7 | DQ0 | DQ0, DQ1 |
| | | | DQ3 | DQ2, DQ3 |
| | | | DQ5 | DQ4, DQ5 |
| | | | DQ6 | DQ6, DQ7 |
| | 16M X 16 | DQ0–DQ15 | DQ0 | DQ0⇒DQ3 |
| | | | DQ7 | DQ4⇒DQ7 |
| | | | DQ11 | DQ8⇒DQ11 |
| | | | DQ12 | DQ12⇒DQ15 |
| | 8M X 32 | DQ0–DQ31 | DQ0 | DQ0⇒DQ7 |
| | | | DQ15 | DQ8⇒DQ15 |
| | | | DQ23 | DQ16⇒DQ23 |
| | | | DQ24 | DQ24⇒DQ31 |

## 256M DRAM ADDRESS AND DATA SPACE COMPRESSION FOR TEST MODE

**Release 7**

## 3.10.3 Word Wide MPDRAM & GRAM

### 3.10.3.1 – 128K & 256K BY 16 MPDRAM IN SOG WITH MULTIPLE CLOCKS

CAPACITY—256K WORDS OF 16 BITS
LOGIC FEATURES—Multiplexed Address
—SERIAL and RAM data ports
There are two versions of these parts: One with 2 $\overline{W}$ and the other with 2 $\overline{CE}$, controlling the lower and upper bytes of data.: 128K & 256K with 2 W, 256K with 2 CE. .
PACKAGE—64 PIN SOG, 12 mm wide, 0.8 mm pin pitch
PIN ASSIGNMENTS—FIG. 3.10.3–1

### 3.10.3.2 – 128K & 256K BY 16 MPDRAM IN TSOP–2 WITH MULTIPLE CLOCKS

CAPACITY—128K AND 256K WORDS OF 16 BITS
LOGIC FEATURES—Multiplexed Address
—SERIAL and RAM data ports
There are two versions of these parts: One with 2 $\overline{W}$ and the other with 2 $\overline{CE}$, controlling the lower and upper bytes of data.: 128K & 256K with 2 $\overline{W}$, 128K & 256K with 2 $\overline{CE}$. .
PACKAGE—70 PIN TSOP–2 10.16 mm wide (0.400"), 23.49 mm long. 0.65 mm pin pitch
NOTE: These parts have essentially the same pin rotation as the parts defined in Par. 3.10.3.1 with the exception of the addition of NC pins in the middle.
PIN ASSIGNMENTS—FIG. 3.10.3–2

### 3.10.3.3 – 256K BY 16 SGRAM IN TSOP–2

CAPACITY—256K WORDS OF 16 BITS
LOGIC FEATURES—Multiplexed Address
—A single data port with Graphics oriented features.
—Synchronous address & control interface.
PACKAGE—50 PIN TSOP–2, 10.16 mm wide (0.400"), 0.8 mm PP
PIN ASSIGNMENTS—FIG. 3.10.3–3
NOTE: This part has the same pinout as the SDRAM part shown in Fig. 3.11.4–1 with the exception of the DSF function on P 33.

### 3.10.3.4 – 256K BY 32 SGRAM IN QFP or TQFP

CAPACITY—256K WORDS OF 32 BITS
LOGIC FEATURES—Multiplexed Address
—A single data port with Graphics oriented features.
—Synchronous address & control interface.
PACKAGE—100 PIN QFP or TQFP, 20 mm X 14 mm, 0.65 mm PP
PIN ASSIGNMENTS—FIG. 3.10.3–4
NOTE: This part has the same pinout as the SDRAM part shown in Fig. 3.11.4–4 with the exception of the DSF function on P 33.

### 3.10.3.5 – 256K BY 32 SGRAM IN TSOP2

CAPACITY—256K WORDS OF 32 BITS
LOGIC FEATURES—Multiplexed Address
—A single data port with Graphics oriented features.
—Synchronous address & control interface.
PACKAGE—80 PIN TSOP2, 10.16 mm wide (0.400"), 0.65 mm PP
PIN ASSIGNMENTS—FIG. 3.10.3–5

### 3.10.3.6 – 256K BY 32 SYNCHRONOUS MPDAM IN TSOP2

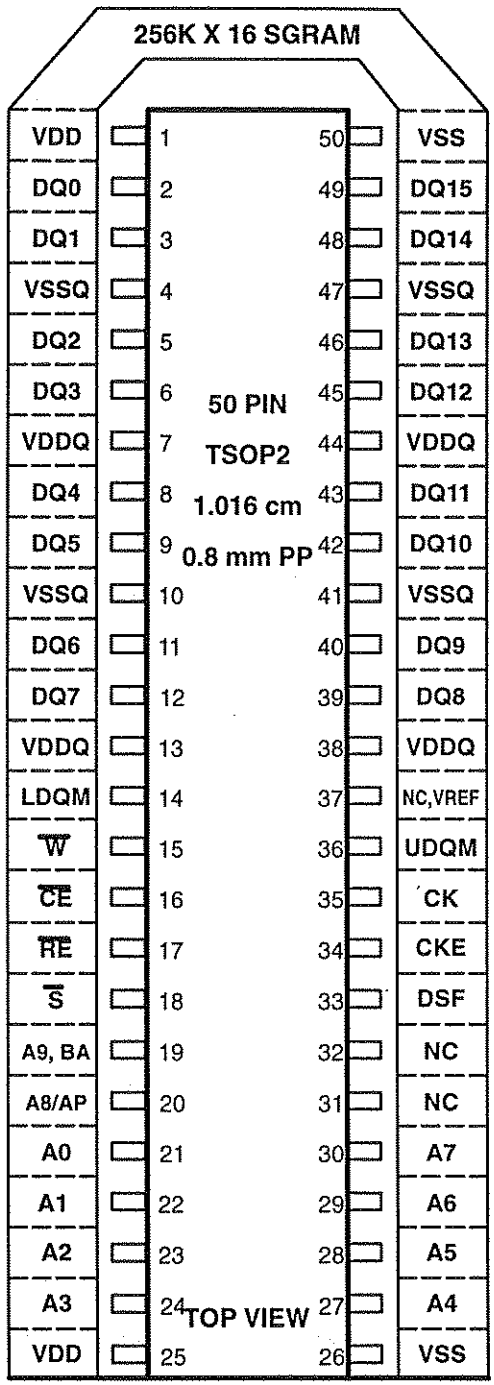
CAPACITY—256K WORDS OF 32 BITS
LOGIC FEATURES—Multiplexed Address
—A multiple data port with Graphics oriented features.
—Synchronous address & control interface.
PACKAGE—120 PIN QFP or TQFP, 20 mm X 14 mm, 0.5 mm PP
PIN ASSIGNMENTS—FIG. 3.10.3–5

### 3.10.3.7 – 256K BY 32 SYNCHRONOUS MPDAM IN TSOP2

CAPACITY—256K WORDS OF 32 BITS
LOGIC FEATURES—Multiplexed Address
—A multiple data port with Graphics oriented features.
—Synchronous address & control interface.
PACKAGE—100 PIN QFP or TQFP, 20 mm X 14 mm, 0.65 mm PP
PIN ASSIGNMENTS—FIG. 3.10.3–6



XILINX EXHIBIT 1012
Page 126




This pinout is the same as the one for the 256K X 16 SDRAM shown in Fig. 3.11.4–1 except for the DSF function on pin 33.

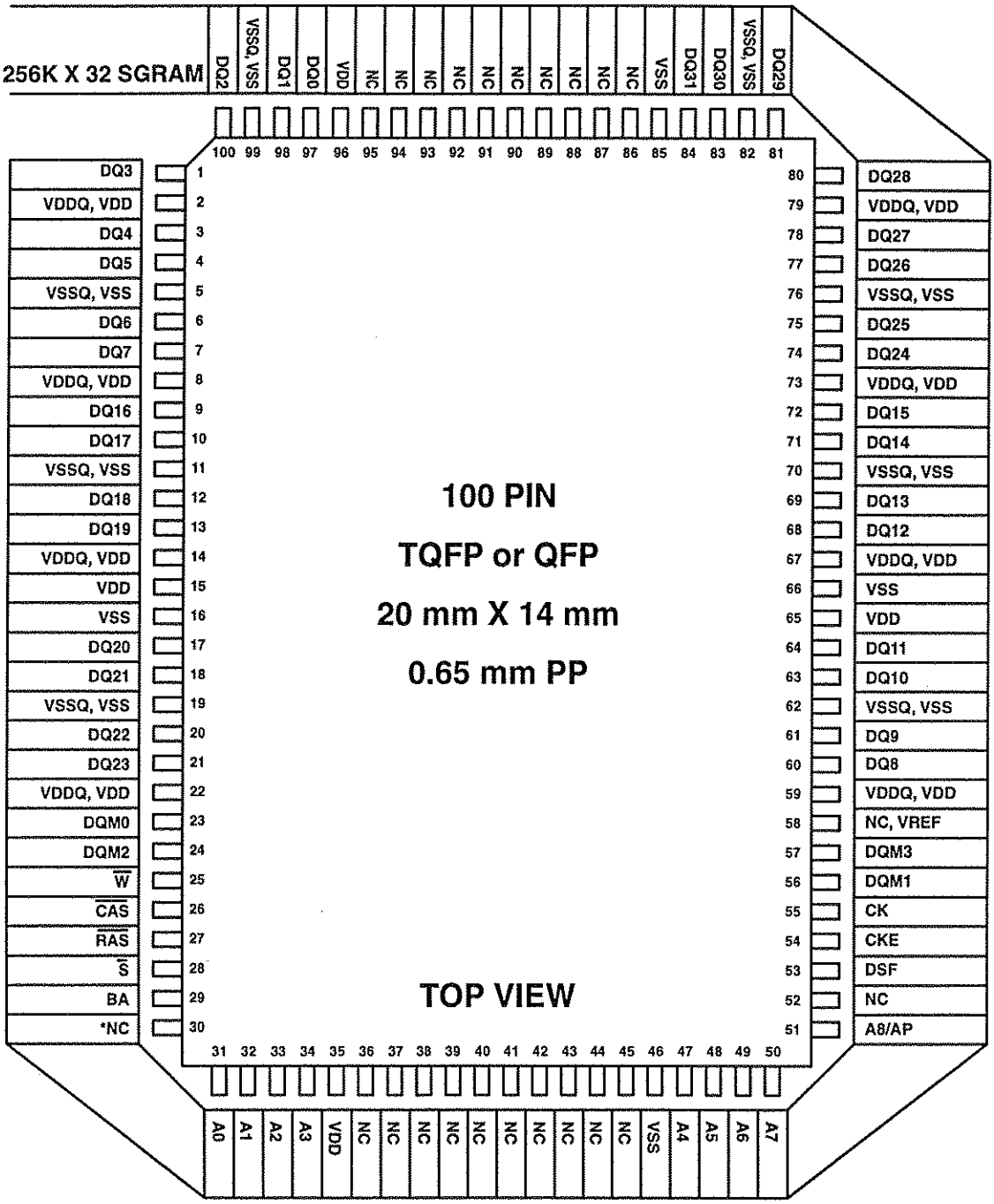
The JEDEC Std. No. 30 designator for the TSOP2 package is PDSO–G

* NOTE—All VDDQ and VSSQ pins may be VDD and VSS at the option of the supplier.

ADDRESS STRUCTURE

| | |
|---|---|
| RA | A0 ⇒ A8 |
| CA | A0 ⇒ A7 |

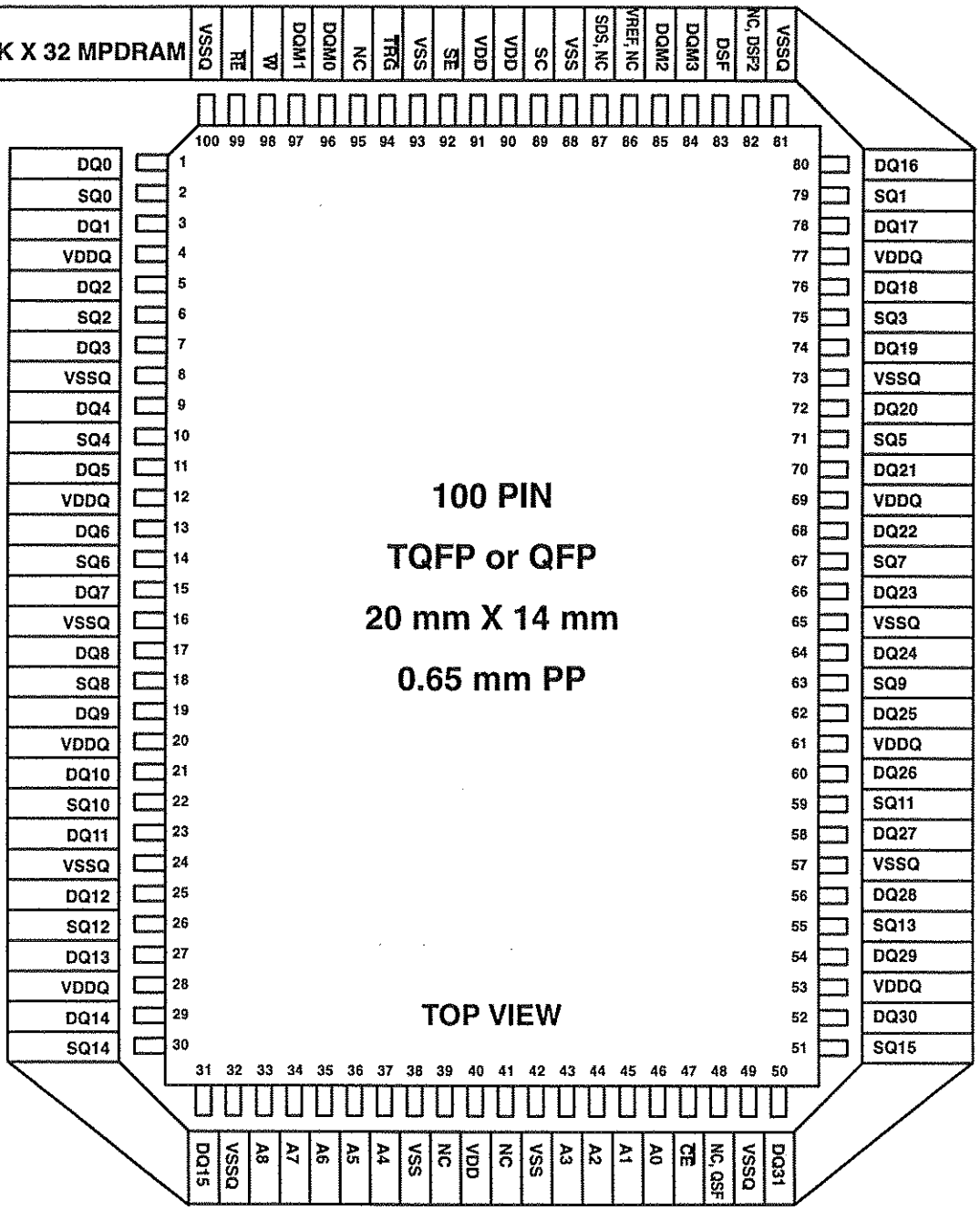
## FIGURE 3.10.3–3
## 256K BY 16 SGRAM IN TSOP2




* In Release 6, Pin 30 had an optional VREF. This was deleted by action of the Committee in Release 7.

## FIGURE 3.10.3–4
## 256K BY 32 SGRAM IN QFP

Release 6c7




**Configuration**
DRAM = 256K X 32
SAM = 512 X 16
ROW ADDRESS A0⇒A8
COLUMN ADDRESS A0⇒A8

## FIGURE 3.10.3–7
## 256K BY 32 MPDRAM IN QFP

Release 7

### 3.10.4.1 - 256K X 4 MPDRAM MINIMUM FEATURE SET TRUTH TABLE

The 256K X 4 MPDRAM described in this Standard must contain, as a minimum, the feature set described in Table 3.10.4-1, 256K X 4 MPDRAM FEATURE SET TRUTH TABLE.

### 3.10.4.2 - 256K X 4 MPDRAM EXTENDED FEATURE SET TRUTH TABLE

The 256K X 4 MPDRAM described in this Standard, in addition to the minimum feature set defined in Table 3.10.4-1, may contain any of the features described in the Table, 256K X 4 MPDRAM FEATURE SET TRUTH TABLE, and still meet the Standard. These logic features must operate exactly as defined in the table to conform to the Standard.

### 3.10.4.3 - MPDRAM BIT WRITE OPTIONAL FEATURE

This feature allows individual data bits of a memory array with a multi bit data interface to be selectively modified during a write cycle while other bits remain unchanged. The timing sequence used to control the feature is shown in figure 3.10.4-1 and operates as follows:

1-If W\ is low at the time that RE\ goes low, the state of the individual DQ pins determines if that data bit is to be written.

2-If DQ is HIGH write is ENABLED for that bit and the data present on DQ at the time that CE\ goes low is written.

3-If DQ is LOW, write is DISABLED for that bit and no subsequent writing can occur during that RE\ cycle.

4-If W\ is high at the time that RE\ goes low but goes low later in the cycle, a normal write cycle will be performed and all data bits will be written.

### 3.10.4.4 - 128K X 8 MPDRAM MINIMUM FEATURE SET TRUTH TABLE

The 128K BY 8 MPDRAM described in this standard must contain, as a minimum, the feature set described in Table 3.10.4-2, 128K X 8 MPDRAM FEATURE SET TRUTH TABLE.

### 3.10.4.5 - 128K X 8 MPDRAM EXTENDED FEATURE SET TRUTH TABLE

The 128K X 8 MPDRAM described in this Standard may, in addition to the minimum feature set defined, contain any of the other features described in Table 3.10.4-2, 128K X 8 MPDRAM FEATURE SET TRUTH TABLE, and still meet the Standard. These logic features must operate exactly as defined in the table to conform to the Standard.

### 3.10.4.6 - 128K X 16, 256K X 8, & 256K X 16 MPDRAM MINIMUM FEATURE SET TRUTH TABLE

The 2Mb & 4Mb density MPDRAMs described in this Standard must contain, as a minimum, the feature set described in Table 3.10.4-3, 2Mb & 4Mb MPDRAM FEATURE SET TRUTH TABLE. Note: Release 5 contains a new TRUTH TABLE.

### 3.10.4.7 - 128K X 16, 256K X 8, & 256K X 16 MPDRAM EXTENDED FEATURE SET TRUTH TABLE INCLUDING REQUIRED MINIMUM OPTIONAL FEATURE SET

The 2Mb & 4Mb density MPDRAMs described in this Standard must, in addition to the minimum basic feature set defined in Par. 3.10.4.6, contain all of the minimum defined set of optional features if any of them are included. In addition, any of the other features described may be included. The basic and optional features are shown in Table 3.10.4-3, 2Mb & 4Mb MPDRAM FEATURE SET TRUTH TABLE. These logic features must operate exactly as defined in the table to conform to the Standard. Note: Release 5 contains a new TRUTH TABLE.

### 3.10.4.8 - SPLIT REGISTER WITH PROGRAMMABLE STOPS FOR MPDRAM

This standard describes an option internal architectural feature which is applicable to the SERIAL PORT in MPSRAMs. The details are shown in Figure 3.10.4-2.

### 3.10.4.8 – SPLIT REGISTER WITH PROGRAMMABLE STOPS FOR MPDRAM

This standard describes an option internal architectural feature which is applicable to the SERIAL PORT in MPSRAMs. The details are shown in Figure 3.10.4–2.

### 3.10.4.9 – PIPELINED FAST PAGE MODE FOR MPDRAM

This standard describes the operational characteristics of an optional serial access data mode for the RAM PORT of MPDRAMs. The details and timing diagrams are given in Figures 3.10.4–3A and 3.10.4–3B.

### 3.10.4.10 – EXTENDED DATA OUT FAST PAGE MODE FOR MPDRAM

The EXTENDED DATA OUT FAST PAGE MODE defined in Sec. 3.9.5, DRAM OPTIONAL Features, on Page 3.9.5–11, Par. 1.4 is also applicable to MPDRAM as is needed. The mode is further defined with timing diagrams in Fig. 3.10.4–4.

### 3.10.4.11 – SAM OPTIONS FOR 4Mb MPDRAM

For 4 Mb MPDRAMs organized as 256K x 16, there are two options for the length of the SAM (Serial Access Memory). It may be either (1), 256 (Half SAM) or (2), 512 bits (Full SAM) for a 512 Column Page Depth. The details of these two options are described in Figs. 3.10.4–5A and 3.10.4–5B.

### 3.10.4.12 – Synchronous GRAM Special Mode Set Procedure

This standard defines a procedure for setting SPECIAL OPERATIONAL MODES into a Synchronous Graphics DRAM. A timing diagram and logic truth table are given in Fig. 3.10.4–6 on Page 3.10.4–15.

### 3.10.4.13 – Synchronous MPDRAM Special Mode Set Procedure

This standard defines a procedure for setting SPECIAL OPERATIONAL MODES into a Synchronous Multiport DRAM. A timing diagram and logic truth table are given in Fig. 3.10.4–7 on Page 3.10.4–16.

### 3.10.4.14 – Synchronous GRAM OPERATIONAL FUNCTION TABLES

This standard gives a set of functional truth tables for Synchronous Graphics DRAM. Three truth tables are given that define all standard operational functions. They are given in Tables 3.10.4–4A⇒C on Pages 3.10.4–17⇒19.

### 3.10.4.15 – 8Mb MPDRAM FEATURE SET FUNCTION TABLE

The 8Mb MPDRAM described in this Standard must contain, as a minimum, the feature set described in Table 3.10.4–15 on Page 3.10.4–8. This standard applies to devices with any interface data word length.

### 3.10.4.16 – Extended Functions for SGRAM and MPDRAM.

These standards define two special write function operations for SGRAM and MPDRAM. The functions defined are:

Write–Per–Bit
Block Write

These logic features must operate exactly as defined in the table to conform to the Standard. Details of the standards are given on Page 3.10.4–6.



XILINX EXHIBIT 1012
Page 132

## SGRAM FUNCTION TABLE

| CURRENT STATE | $\overline{S}$ | $\overline{TR}$ | DSF | $\overline{RE}$ | $\overline{CE}$ | $\overline{W}$ | An | ACTION |
|---|---|---|---|---|---|---|---|---|
| IDLE | H | X | X | X | X | X | X | NOP |
| | L | X | X | H | H | H | X | NOP |
| | L | X | X | H | H | L | X | ILLEGAL[2] |
| | L | H | X | H | L | X | BA, CA | ILLEGAL[2] |
| | L | L | X | H | L | H | CA | Latch Tap Address[7] |
| | L | H | L | L | H | H | BA, RA | Row (&Bank) active; Latch Row Address; No Mask |
| | L | H | H | L | H | H | BA, RA | Row (&Bank) active; Latch Row Address; Use Mask |
| | L | L | L | L | H | H | BA, RA | Read Transfer; Latch Row Address ⇒ Precharge |
| | L | L | H | L | H | H | BA, RA | Split Read Transfer; Latch Row Address ⇒ Precharge |
| | L | H | L | L | H | L | BA, AP | NOP[4] |
| | L | H | H | L | H | L | X | ILLEGAL |
| | L | L | X | L | H | L | X | ILLEGAL |
| | L | H | L | L | L | H | X | Auto–Refresh[6] |
| | L | H | H | L | L | H | X | ILLEGAL |
| | L | L | X | L | L | H | X | ILLEGAL |
| | L | H | L | L | L | L | Op–code | Mode Register Access[6] |
| | L | H | H | L | L | L | Op–code | Special Register Access[5] |
| | L | L | X | L | L | L | X | ILLEGAL |
| ROW ACTIVE | H | X | X | X | X | X | X | NOP |
| | L | X | X | H | H | H | X | NOP |
| | L | X | X | H | H | L | X | ILLEGAL[2] |
| | L | H | L | H | L | H | BA, CA, AP | Begin Read; Latch CA; Determine AP |
| | L | H | H | H | L | H | X | ILLEGAL |
| | L | L | X | H | L | H | CA | ILLEGAL[2] |
| | L | H | L | H | L | L | BA, CA, AP | Begin Write; Latch CA; Determine AP |
| | L | H | H | H | L | L | BA, CA, AP | Block Write; Latch CA; Determine AP |
| | L | L | X | H | L | L | X | ILLEGAL |
| | L | X | X | L | H | H | BA, RA | ILLEGAL[2] |
| | L | H | L | L | H | L | BA, AP | Precharge |
| | L | H | H | L | H | L | X | ILLEGAL |
| | L | L | X | L | H | L | X | ILLEGAL |
| | L | X | X | L | L | H | X | ILLEGAL |
| | L | H | L | L | L | L | Op–code | ILLEGAL |
| | L | H | H | L | L | L | Op–code | Special Register Access[5] |
| | L | L | X | L | L | L | X | ILLEGAL |

## TABLE 3.10.4–4 A
## SGRAM FUNCTION TABLE

## SGRAM FUNCTION TABLE (continued)

| CURRENT STATE | $\overline{S}$ | $\overline{TR}$ | DSF | $\overline{RE}$ | $\overline{CE}$ | $\overline{W}$ | An | ACTION |
|---|---|---|---|---|---|---|---|---|
| READ | H | X | X | X | X | X | X | NOP (Continue Burst to End;⇒Row Active) |
| | L | X | X | H | H | H | X | NOP(Continue Burst to End;⇒Row Active) |
| | L | H | L | H | H | L | X | RESERVED (Term. Burst);⇒Row Active |
| | L | H | H | H | H | L | X | ILLEGAL |
| | L | L | X | H | H | L | X | ILLEGAL |
| | L | H | L | H | L | H | BA, CA, AP | Term Burst, New Read, Determine AP[3] |
| | L | H | H | H | L | H | X | ILLEGAL |
| | L | L | X | H | L | H | CA | ILLEGAL[2] |
| | L | H | L | H | L | L | BA, CA, AP | Term Burst, Start Write, Determine AP[3] |
| | L | H | H | H | L | L | BA, CA, AP | Term Burst, Start Write, Determine AP[3] |
| | L | L | X | H | L | L | X | ILLEGAL |
| | L | X | X | L | H | H | BA, RA | ILLEGAL[2] |
| | L | H | L | L | H | L | BA, AP | Term Burst, Precharge Timing for Reads |
| | L | H | H | L | H | L | X | ILLEGAL |
| | L | L | X | L | H | L | X | ILLEGAL |
| | L | X | X | L | L | X | X | ILLEGAL |
| WRITE | H | X | X | X | X | X | X | NOP(Continue Burst to End;⇒Row Active) |
| | L | X | X | H | H | H | X | NOP(Continue Burst to End;⇒Row Active) |
| | L | H | L | H | H | L | X | RESERVED (Term Burst);⇒Row Active |
| | L | H | H | H | H | L | X | ILLEGAL |
| | L | L | X | H | H | L | X | ILLEGAL |
| | L | H | L | H | L | H | BA, CA, AP | Term Burst, Start Read, Determine AP[3] |
| | L | H | H | H | L | H | X | ILLEGAL |
| | L | L | X | H | L | H | CA | ILLEGAL[2] |
| | L | H | L | H | L | L | BA, CA, AP | Term Burst, New Write, Determine AP[3] |
| | L | H | H | H | L | L | BA, CA, AP | Term Burst, Block Write, Determine AP[3] |
| | L | L | X | H | L | L | X | ILLEGAL |
| | L | X | X | L | H | H | BA, RA | ILLEGAL[2] |
| | L | H | L | L | H | L | BA, AP | Term Burst, Precharge[3] |
| | L | X | X | L | L | X | X | ILLEGAL |
| READ with AUTO Precharge | H | X | X | X | X | X | X | NOP (Continue Burst to End;⇒Precharge) |
| | L | X | X | H | H | H | X | NOP (Continue Burst to End;⇒Precharge) |
| | L | X | X | H | H | L | X | ILLEGAL[2] |
| | L | X | X | H | L | H | BA, CA, AP | ILLEGAL[2] |
| | L | X | X | H | L | L | X | ILLEGAL |
| | L | X | X | L | H | X | BA, RA, AP | ILLEGAL[2] |
| | L | X | X | L | L | X | X | ILLEGAL |
| WRITE with AUTO Precharge | H | X | X | X | X | X | X | NOP (Continue Burst to End;⇒Precharge) |
| | L | X | X | H | H | H | X | NOP (Continue Burst to End;⇒Precharge) |
| | L | X | X | H | H | L | X | ILLEGAL[2] |
| | L | X | X | H | L | H | BA, CA, AP | ILLEGAL[2] |
| | L | X | X | H | L | L | X | ILLEGAL |
| | L | X | X | L | H | X | BA, RA, AP | ILLEGAL[2] |
| | L | X | X | L | L | X | X | ILLEGAL |

## TABLE 3.10.4–4 B
## SGRAM FUNCTION TABLE (Continued)

## SGRAM FUNCTION TABLE (continued)

| CURRENT STATE | $\overline{S}$ | TR | $\overline{DSF}$ | $\overline{RE}$ | $\overline{CE}$ | $\overline{W}$ | An | ACTION |
|---|---|---|---|---|---|---|---|---|
| Precharging | H | X | X | X | X | X | X | NOP⇒idle after tRP |
| | L | X | X | H | H | H | X | NOP⇒idle after tRP |
| | L | X | X | H | H | L | X | ILLEGAL[2] |
| | L | H | X | H | L | X | BA, CA, AP | ILLEGAL[2] |
| | L | L | X | H | L | H | CA | Latch Tap Address[7] |
| | L | X | X | L | H | H | BA, RA | ILLEGAL[2] |
| | L | X | X | L | H | L | BA, AP | NOP[4] |
| | L | X | X | L | L | X | X | ILLEGAL |
| ROW Activating | H | X | X | X | X | X | X | NOP⇒Row Active after tRCD |
| | L | X | X | H | H | H | X | NOP⇒Row Active after tRCD |
| | L | X | X | H | H | H | X | ILLEGAL[2] |
| | L | X | X | H | L | X | BA, CA, AP | ILLEGAL[2] |
| | L | X | X | L | H | H | BA, RA | ILLEGAL[2] |
| | L | X | X | L | H | L | BA, AP | ILLEGAL[2] |
| | L | X | X | L | L | X | X | ILLEGAL |
| WRITE Recovering | H | X | X | X | X | X | X | NOP |
| | L | X | X | H | H | H | X | NOP |
| | L | X | X | H | H | L | X | ILLEGAL[2] |
| | L | X | X | H | L | X | BA, CA, AP | ILLEGAL[2] |
| | L | X | X | L | H | H | BA, RA | ILLEGAL[2] |
| | L | X | X | L | H | L | BA, AP | ILLEGAL[2] |
| | L | X | X | L | L | X | X | ILLEGAL |
| Refreshing | H | X | X | X | X | X | X | NOP⇒idle after tRP |
| | L | X | X | H | H | X | X | NOP⇒idle after tRP |
| | L | X | X | H | L | X | X | ILLEGAL |
| | L | X | X | L | H | X | X | ILLEGAL |
| | L | X | X | L | L | X | X | ILLEGAL |
| Mode Register Accessing | H | X | X | X | X | X | X | NOP |
| | L | X | X | H | H | H | X | NOP |
| | L | X | X | H | H | L | X | ILLEGAL |
| | L | X | X | H | L | X | X | ILLEGAL |
| | L | X | X | L | X | X | X | ILLEGAL |

ABBREVIATIONS

RA = Row Address BA = Bank Address Term = Terminate

CA = Column Address AP = Auto Precharge NOP = No Operation

NOTES:

1. All entries assume that CKE was active (HIGH) during the preceeding clock cycle and the current clock cycle.
2. Illegal to bank in specified state; function may be legal in the bank indicated by BA, depending on the state of that bank.
3. Must satisfy the "2n–rule", bus contention, bus turn around, and/or write recovery requirements.
4. NOP to bank precharging or in idle state. May precharge bank(s) indicated by BA (and AP).
5. Legal only if all banks are in idle or row active state.
6. Illegal if any bank is not idle.
7. Illegal if any bank is not idle or precharging.

ILLEGAL = Device operation and/or data–integrity are not guaranteed

## TABLE 3.10.4–4 C
## SGRAM FUNCTION TABLE (Continued)

**8 Mb BURST MPDRAM FUNCTION TRUTH TABLE**

| CYCLE | RE Fall | | | | | CE | | A(n) | | DQ(n) | | | FUNCTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CODE | CE | TRG | W | DSF1 | DSF2 | DSF1 | DSF2 | RE | CE. | RE | CE | DQM | |
| OPTION | 0 | 0 | 0 | 0 | 0 | — | 0 | MODE | — | X | — | X | OPTIONAL |
| CBRR | 0 | X | 1 | 0 | 0 | — | 0 | X | — | X | — | X | CBR REFRESH (OPTION RESET) |
| CBRS | 0 | X | 0 | 1 | 0 | — | 0 | STOP Addr | — | X | — | X | CBR REFRESH STOP POINT SET |
| CBRSD | 0 | X | 0 | 1 | 1 | — | 0 | X | — | X | — | X | CBR REFRESH SDS MODE SET |
| CBRN | 0 | X | 1 | 1 | 0 | — | 0 | X | — | X | — | X | CBR REFRESH NO RESET |
| RT | 1 | 0 | 1 | 0 | 0 | 0 | 0 | ROW | TAP | X | X | X | READ TRANSFER CYCLE |
| SRT | 1 | 0 | 1 | 1 | 0 | 0 | 0 | ROW | TAP | X | X | X | SPLIT READ TRANSFER CYCLE |
| RWM | 1 | 1 | 0 | 0 | 0 | 0 | 0 | ROW | COL | WPBM | DATA IN | DQM | READ MASKED WRITE CYCLE |
| BRWM | 1 | 1 | 0 | 0 | 1 | 0 | 0 | ROW | COL | WPBM | DATA IN | DQM | BURST READ MASKED WRITE CYCLE |
| BWM | 1 | 1 | 0 | 0 | 0 | 1 | 0 | ROW | CA3–CA8 CA0=CR | WPBM | COL ADDR MASK | DQM | MASKED BLOCK WRITE CYCLE |
| RW | 1 | 1 | 1 | 0 | 0 | 0 | 0 | ROW | COL | X | DATA IN | DQM | READ WRITE CYCLE (NO MASK) |
| BRW | 1 | 1 | 1 | 0 | 1 | 0 | 0 | ROW | COL | X | DATA IN | DQM | BURST READ WRITE CYCLE (NO MASK) |
| BI | — | — | — | — | — | 0 | 1 | ROW | COL | X | X | X | BURST INTERRUPT |
| BW | 1 | 1 | 1 | 0 | 0 | 1 | 0 | ROW | CA3–CA8 CA0 = CR | X | COL ADDR. MASK | DQM | BLOCK WRITE |
| LCR | 1 | 1 | 1 | 1 | 0 | 1 | 0 | ROW | CA0 = CR | X | COLOR | DQM | LOAD COLOR REGISTER |
| LMR | 1 | 1 | 1 | 1 | 0 | 0 | 0 | ROW | X | X | WPBM | DQM | LOAD MASK REGISTER |

X = Don't care 0 or 1 — = NOT APPLICABLE

NOTES: CR = 0 selects Color Register 0 CR = 1 selects Color Register 1
All states not defined are illegal. If used, device operation and/or data integrity are not guaranteed.

**BYTE ENABLE TRUTH TABLE**

| | | CE FALLING |
|---|---|---|
| DQM0–DQM3 | | |
| DQM0 | 0 | Byte Write Enable (DQ0–DQ7) |
| | 1 | Byte Write Disable (DQ0–DQ7) |
| DQM1 | 0 | Byte Write Enable (DQ8–DQ15) |
| | 1 | Byte Write Disable (DQ8–DQ15) |
| DQM2 | 0 | Byte Write Enable (DQ16–DQ23) |
| | 1 | Byte Write Disable (DQ16–DQ23) |
| DQM3 | 0 | Byte Write Enable (DQ24–DQ31) |
| | 1 | Byte Write Disable (DQ24–DQ31) |

**8M BURST MPDRAM FUNCTION TABLE**

**8MB BURST MPDRAM FUNCTION TABLE**
**TABLE 3.10.4–5**

## Extended Functions for SGRAM and SVRAM

**WRITE–PER–BIT** WPB, for Synchronous Video RAMs (SVRAM), and Synchronous Graphics RAMs (SGRAM) is a function that selectively masks bits of data being written to the devices. The mask is stored in an internal register and applied to each bit of data written when enabled.

1) A Bank Active Command with DSF = 1 (high) enables Write–per–bit for the associated bank. A bank active command with DSF = O (low) disables Write–Per–Bit for the associated bank.

2) The mask used for Write per–bit operations is stored in the Mask Register accessed by Special Register Access command. When a mask bit = 1 (high), the associated data bit is written when a Write Command is executed and Write–per–bit has been enabled for the bank being written. When a mask bit = O (low) the associated data bit is unaltered when a Write Command is executed and Write–per–bit has been enabled for the bank being written.

3) No additional, timing conditions are required for Write per–bit operations. Write–per–bit writes can be either single writes, burst writes, or block writes.

4) DQM masking is the same for WPB and non–WPB writes.

**BLOCK WRITE** for Synchronous Multi–port DRAMs (SMPRAM), and Synchronous Graphics RAMs (SGRAM). A feature allowing the simultaneous writing of consecutive columns of data within RAM device during a single access cycle. During block write the data to be written comes from an internal "color" register and the DQ I/O pins are used for independent column selection. The block of columns to be written is aligned on 8 column boundaries and is defined by the column address with the 3 LSB's ignored.

1) A Write Command with DSF = 1 (high) enables Block Write for the associated bank. A Write Command with DSF = O (low) disables Block Write for the associated bank.

2) The block size is 8 columns. Where column = "n" bits for by "n" part.

3) The Color Register is the same width as the data port of the part. It is written via a special register access where data present on the DQ pins is copied into the internal color register. The color register provides the data to be copied to the 8 column locations during a block write cycle as masked by the DQ column select, WPB mask (if enabled), and DQM byte mask.

4) Column data masking is provided on an individual column basis for each byte of data. The column mask is driven on the DQ pins during a block write command. The DQ column mask function is segmented on a per byte basis (i.e. DQ[0:7] provides the column mask for data byte [0;7], DQ[8.15] provides the column mask for data byte [8:15] and so on). A DQ column mask of 1 (high) enables the particular column to be written while a value of 0 (low) disables writing of the data. The relationship between DQ bits and column within the block is logically equivalent within each byte (i.e. DQ[0] masks column [0] for data bits [0:7] DQ[8] masks column [0] for data bits [8:15], DQ[1] masks column [1] for data bits [0:7], DQ[9] masks column [1] for data bits 18:15], etc.).

5) Block Writes are always non–burst, independent of the burst length that has been programmed into the Mode Register. Back–to–back Block Writes are allowed provided that the specified Block Write cycle time is satisfied.

6) If Write–per–bit was enabled to the bank by executing a Bank Active Command with DSF=1 (high), then write–per–bit masking of the Color Register data is enabled. If Write–per–bit was disabled to the bank by executing a Bank Active Command with DSF=O (Low), then write–per–bit masking of the color Register data is disabled.

7) DQM masking provides independent data byte masking during block write exactly the same as It does during normal write operations, except that the control is extended to the 8 consecutive columns of the block write.

## 3.11.2 NIBBLE WIDE SDRAM

### 3.11.2.1 – 4M BY 4 SDRAM IN TSOP2

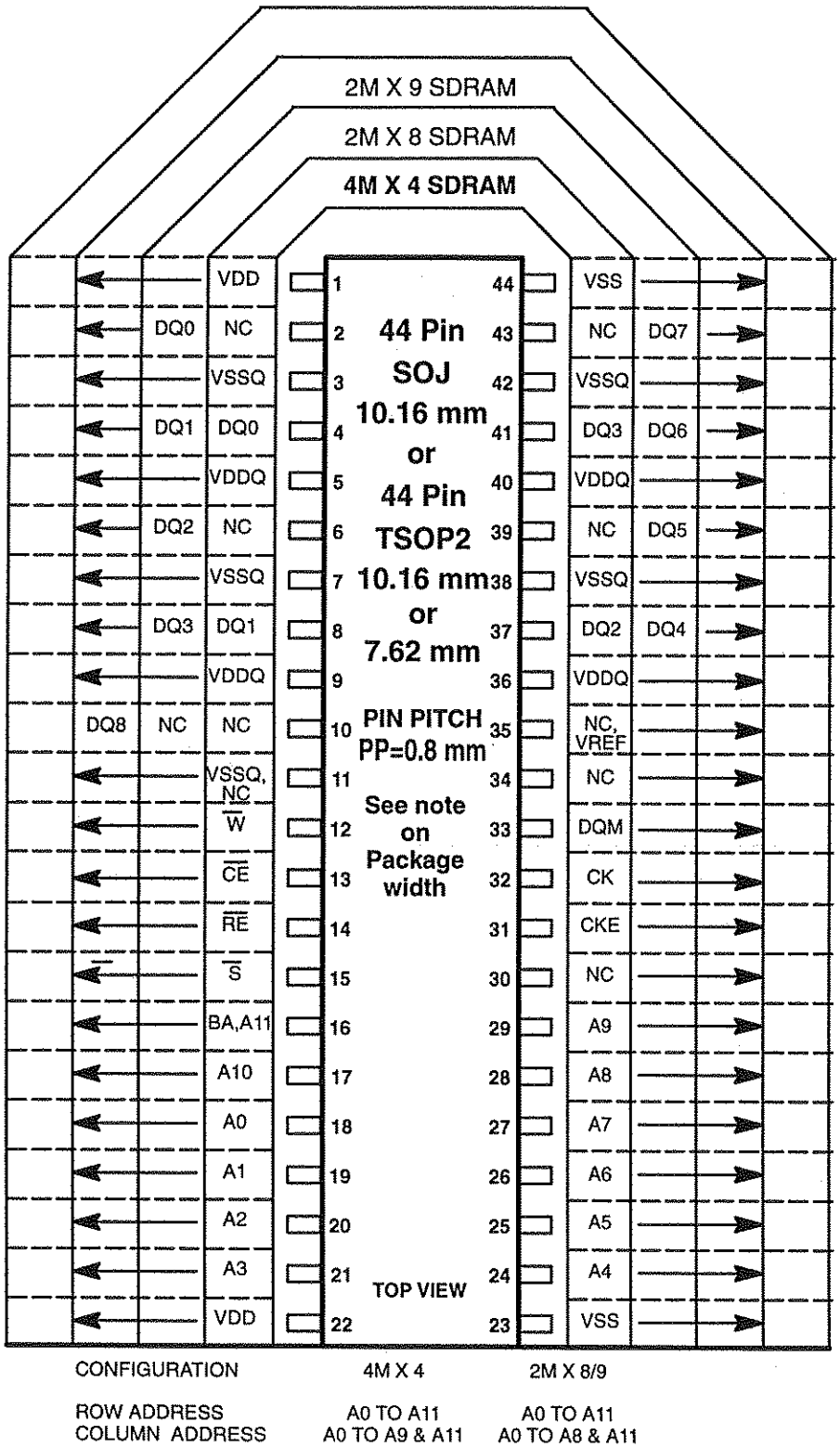
CAPACITY—4M WORDS OF 4 BITS
LOGIC FEATURES—This device will contain all of the logic features described in Sec. 3.11.5
PACKAGE—44 Pin TSOP2, 7.62 mm or 10.16 mm WIDE, 0.8mm PIN PITCH
—44 Pin SOJ 10.16 mm WIDE, 0.8mm PIN PITCH
PIN ASSIGNMENT—Fig. 3.11.2–1

### 3.11.2.2 – 16M BY 4 SDRAM IN TSOP2

CAPACITY—16M WORDS OF 4 BITS
LOGIC FEATURES—This device will contain all of the logic features described in Sec. 3.11.5
PACKAGE—54 Pin TSOP2, 10.16 mm WIDE, 0.8mm PIN PITCH
PIN ASSIGNMENT—Fig. 3.11.2–1

### 3.11.2.3 – 64M BY 4 SDRAM PIN ROTATION

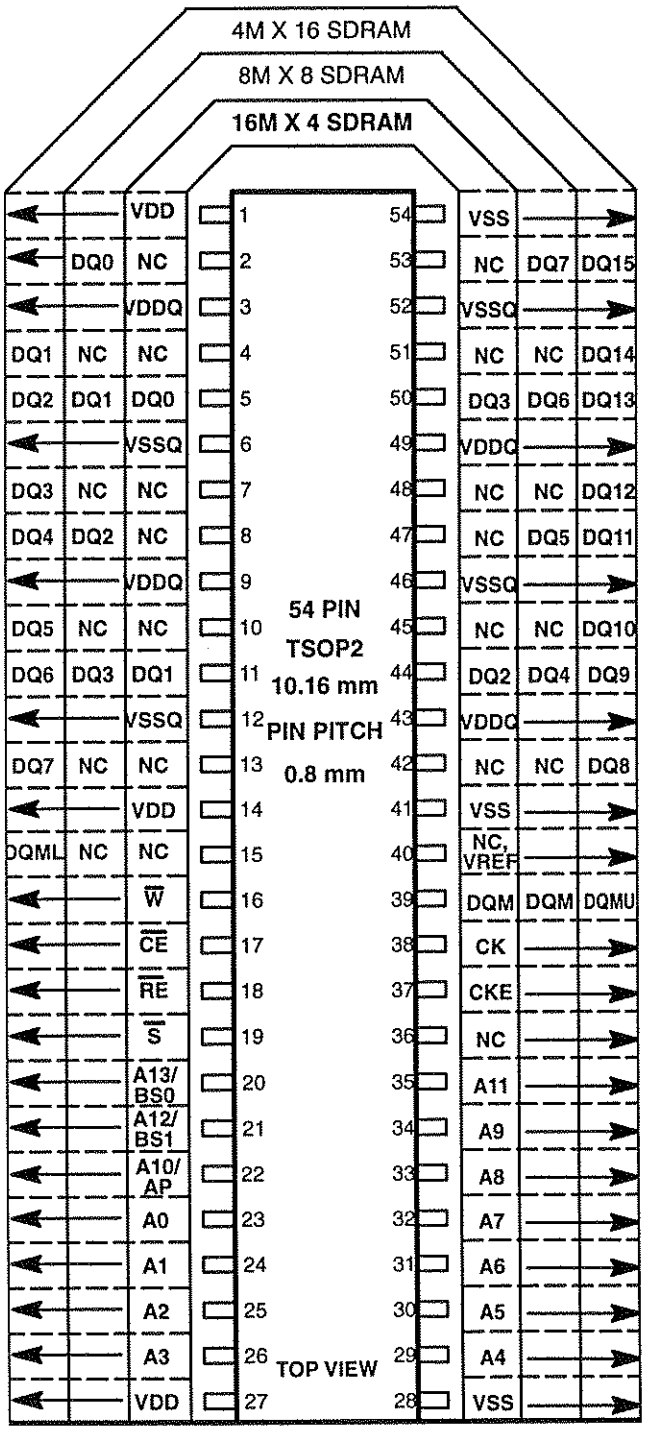
CAPACITY—64M WORDS OF 4 BITS
LOGIC FEATURES—This device will contain all of the logic features described in Sec. 3.11.5
PACKAGE—TSOP2, PIN COUNT AND DIMENSIONS NOT DEFINED
PIN ASSIGNMENT—Fig. 3.11.2–5
**NOTE: This standard defines a pin rotation only. The package details, dimension and pin count, are not defined at this time.**




Notes:
1) The VREF option on P35 was added when the 0.3" package was approved.

2) The JEDEC Std. No 30 designator for the TSOP2 package is PDSO–G
The 4M X 4 and 2M X 8 parts are also approved for delivery in a 7.62 mm package.

**FIGURE 3.11.2–1**
**4M X 4 SDRAM IN TSOP2**




| | ROW ADDR. | COL ADDR |
|---|---|---|
| X4 | A0⇒A13 | A0⇒A9 |
| X8 | A0⇒A13 | A0⇒A8 |
| X16 | A0⇒A13 | A0⇒A7 |

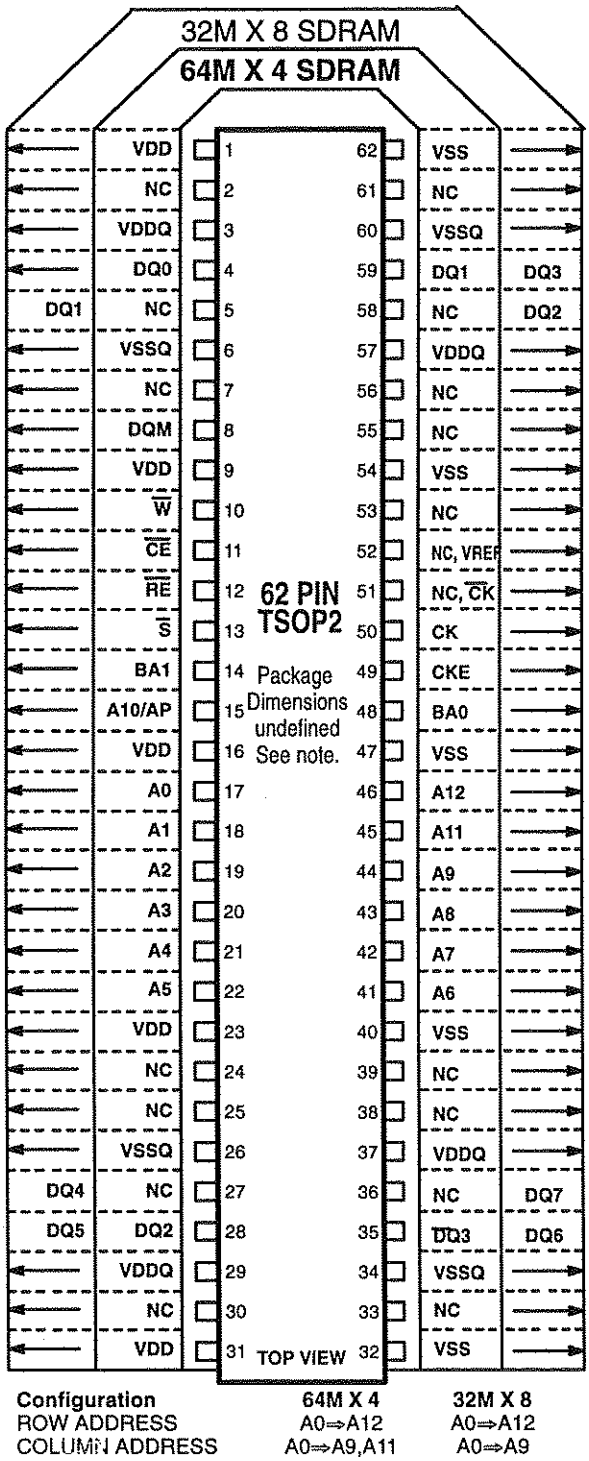
| | |
|---|---|
| A10 | AUTO PRECHARGE |

| BANKS | BANK SELECT ADDRESS |
|---|---|
| 4 | A13/A12 |
| 2 | A13 |

* PACKAGE NOTES:

The JEDEC Std. 30 term for the TSOP–2 package is PDSO–G.

**FIGURE 3.11.2–2**
**16M BY 4 SDRAM IN TSOP2**




| Configuration | 64M X 4 | 32M X 8 |
|---|---|---|
| ROW ADDRESS | A0⇒A12 | A0⇒A12 |
| COLUMN ADDRESS | A0⇒A9,A11 | A0⇒A9 |

NOTES

**1. Pin numbers and pin count are for reference only. This is a pin rotation only. Package dimensions are not specified at this stage.**

2. CBR refresh is the only standardized method of refreshing non–synchronous DRAMs with densities of 256Mb and higher.

3. The standard refresh interval (tREF) for 256Mb DRAMs is 64ms. (7.8 µs per row with 8K rows, 3.9 µs with 16K rows.

4. (NC, VREF) is VREF on devices that require an external voltage reference.

5. The VDDQ designator is used when the power supply pins for the DQ I/O drivers are internally dc isolated from the other VDD power supply pins.

6. The VSSQ designator is used when the ground reference pins for the DQ I/O drivers are internally isolated from the primary ground references (VSS).

7. BA0 is the Least Significant Bank Addr.

8. BA1 is the Most Significant Bank Addr.

9. A10/AP is row addr. A10, autoprecharge and precharge all banks input.

* NOTE: The JEDEC Std. 0 term for the TSOP–2 package is PDSO–G.

**Pin numbers and pin count are for reference only. This is a pin rotation only. Package dimensions are not specified at this stage.**

## FIGURE 3.11.2–3
## 64M BY 4 SDRAM PIN ROTATION IN TSOP2

## 3.11.3 BYTE WIDE SDRAM

### 3.11.3.1 – 2M BY 8 or 9 SDRAM IN TSOP2

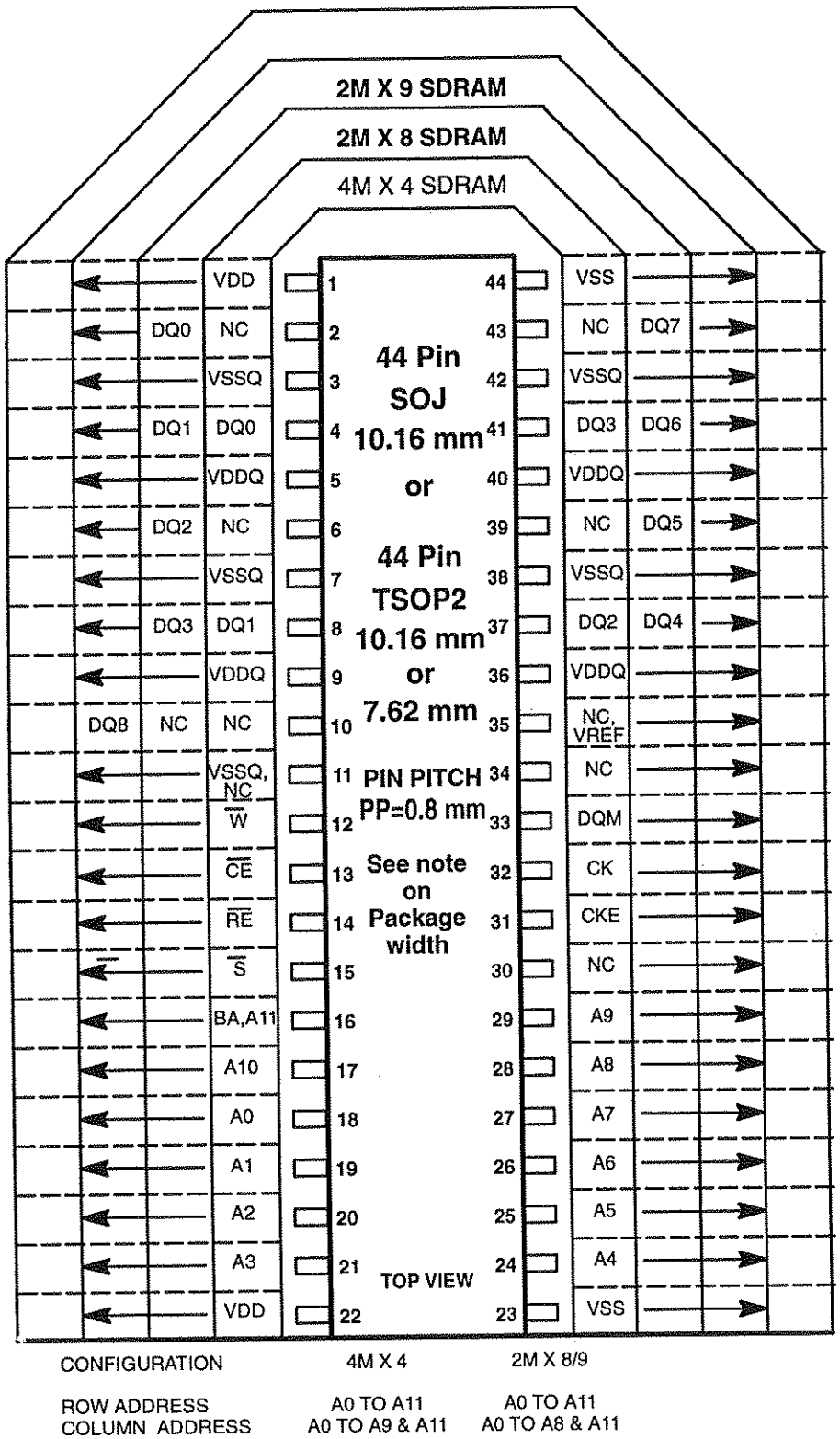
CAPACITY—2M WORDS OF 8 or 9 BITS
LOGIC FEATURES—This device will contain all of the logic features described in Sec. 3.11.5
ELECTRICAL INTERFACE—TTL or LVTTL
PACKAGE—44 Pin TSOP2, 7.62 mm WIDE, 0.8mm PIN PITCH (2M X 8 part only)
PACKAGE—44 Pin TSOP2, 10.16 WIDE, 0.8mm PIN PITCH
PACKAGE—44 Pin SOJ, 10.16 WIDE, 0.8mm PIN PITCH
PIN ASSIGNMENT—Fig. 3.11.3–1

### 3.11.3.2 – 8M BY 8 SDRAM IN TSOP2

CAPACITY—8M WORDS OF 8 BITS
LOGIC FEATURES—This device will contain all of the logic features described in Sec. 3.11.5
PACKAGE—54 Pin TSOP2, 10.16 mm WIDE, 0.8mm PIN PITCH
PIN ASSIGNMENT—Fig. 3.11.3–2

### 3.11.3.3 – 32M BY 8 SDRAM PIN ROTATION

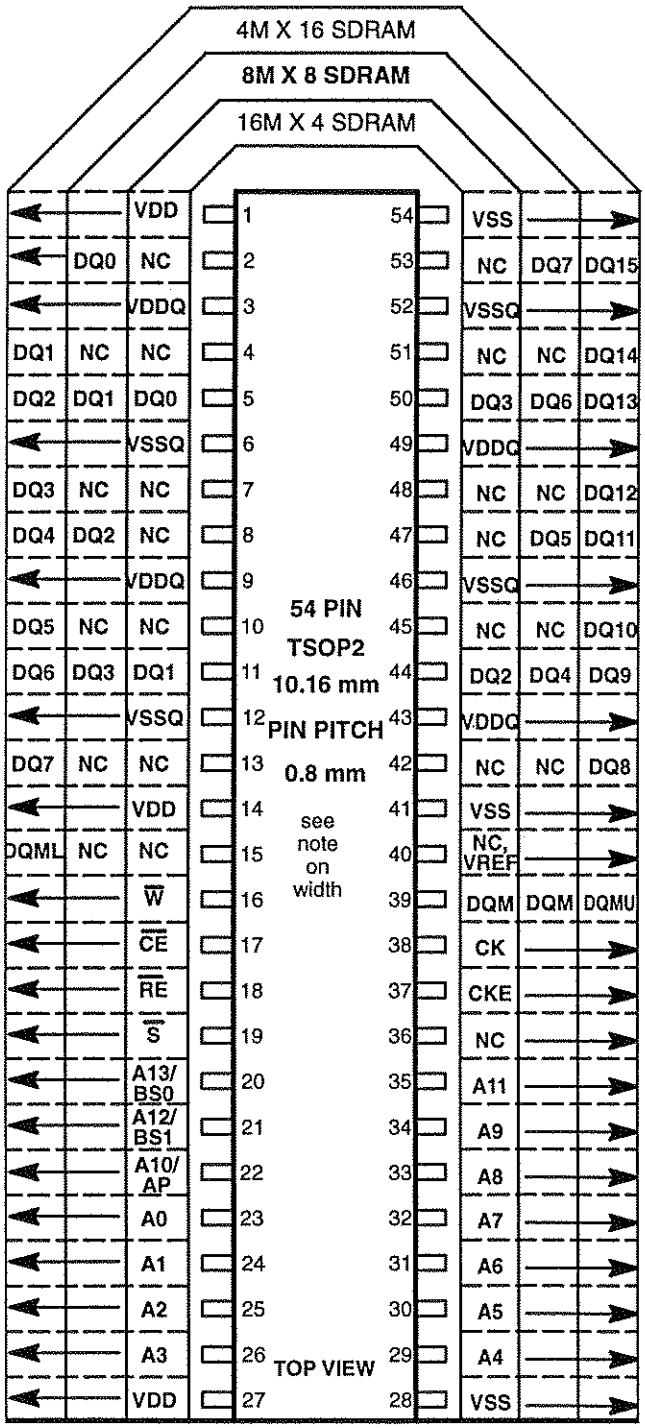
CAPACITY—32M WORDS OF 8 BITS
LOGIC FEATURES—This device will contain all of the logic features described in Sec. 3.11.5
PACKAGE—TSOP2, PIN COUNT AND DIMENSIONS NOT DEFINED
PIN ASSIGNMENT—Fig. 3.11.3–5
**NOTE: This standard defines a pin rotation only. The package details, dimension and pin count, are not defined at this time.**




Notes:
1) The VREF option on P35 was added when the 0.3" package was approved.

2) The JEDEC Std. No 30 designator for the TSOP2 package is PDSO–G
The 4M X 4 and 2M X 8 parts are also approved for delivery in a 7.62 mm package.

**FIGURE 3.11.3–1**
**2M BY 8 OR 9 SDRAM IN TSOP2**




| | ROW ADDR. | COL ADDR |
|---|---|---|
| X4 | A0⇒A13 | A0⇒A9 |
| X8 | A0⇒A13 | A0⇒A8 |
| X16 | A0⇒A13 | A0⇒A7 |

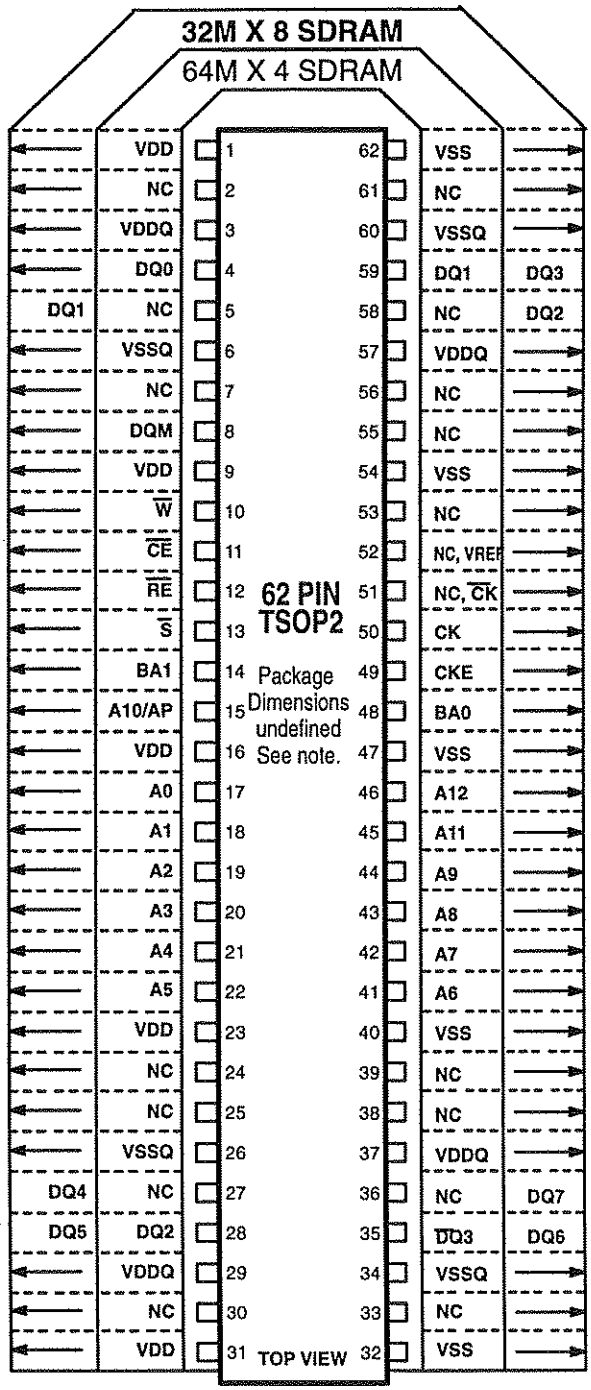
| | |
|---|---|
| A10 | AUTO PRECHARGE |

| BANKS | BANK SELECT ADDRESS |
|---|---|
| 4 | A13/A12 |
| 2 | A13 |

* PACKAGE NOTES:

The JEDEC Std. 30 term for the TSOP–2 package is PDSO–G.

## FIGURE 3.11.3–2
## 8M BY 8 SDRAM IN TSOP2




| Configuration | 64M X 4 | 32M X 8 |
|---|---|---|
| ROW ADDRESS | A0⇒A12 | A0⇒A12 |
| COLUMN ADDRESS | A0⇒A9,A11 | A0⇒A9 |

NOTES

**1. Pin numbers and pin count are for reference only. This is a pin rotation only. Package dimensions are not specified at this stage.**

2. CBR refresh is the only standardized method of refreshing non–synchronous DRAMs with densities of 256Mb and higher.

3. The standard refresh interval (tREF) for 256Mb DRAMs is 64ms. (7.8 µs per row with 8K rows, 3.9 µs with 16K rows.

4. (NC, VREF) is VREF on devices that require an external voltage reference.

5. The VDDQ designator is used when the power supply pins for the DQ I/O drivers are internally dc isolated from the other VDD power supply pins.

6. The VSSQ designator is used when the ground reference pins for the DQ I/O drivers are internally isolated from the primary ground references (VSS).

7. BA0 is the Least Significant Bank Addr.

8. BA1 is the Most Significant Bank Addr.

9. A10/AP is row addr. A10, autoprecharge and precharge all banks input.

* NOTE: The JEDEC Std. 0 term for the TSOP–2 package is PDSO–G.

**Pin numbers and pin count are for reference only. This is a pin rotation only. Package dimensions are not specified at this stage.**

## FIGURE 3.11.3–3
## 32M BY 8 SDRAM PIN ROTATION IN TSOP2

## 3.11.4 WORD WIDE SDRAM

### 3.11.4.1 – 256K BY 16 AND 1M BY 16 & 18 SDRAM IN TSOP2

CAPACITY—256K WORDS OF 16 BITS AND 1M WORDS OF 16 OR 18
LOGIC FEATURES—This device will contain all of the logic features described in Sec. 3.11.5
ELECTRICAL INTERFACE—TTL or LOWER LEVEL INTERFACE CONSISTENT WITH THE VALUE OF VDD CHOSEN.
PACKAGE—50 Pin SOJ, 10.16 mm WIDE, 0.8mm PIN PITCH
PACKAGE—50 Pin TSOP2, 0.400" WIDE (10.16 mm), 0.8mm PIN PITCH
PIN ASSIGNMENT—Fig. 3.11.4–1

NOTE: The 256K part has the same pinout as the SGRAM part shown in Fig. 3.10.3–3 with the exception of the DSF function on P 33.

### 3.11.4.2 – 2M & 4M BY 16 SDRAM IN TSOP2

CAPACITY—2M or 4M WORDS OF 16 BITS
LOGIC FEATURES—This device will contain all of the logic features described in Sec. 3.11.5
PACKAGE—54 Pin TSOP2, 10.16 mm WIDE, 0.8mm PIN PITCH
PIN ASSIGNMENT—Fig. 3.11.4–2

### 3.11.4.3 – 16M BY 16 SDRAM IN TSOP2 PIN ROTATION

CAPACITY—16M WORDS OF 16 BITS
LOGIC FEATURES—This device will contain all of the logic features described in Sec. 3.11.5
—This standard is for a 4 Bank version only.
PACKAGE—TSOP2, PIN COUNT AND DIMENSIONS NOT DEFINED
PIN ASSIGNMENT—Fig. 3.11.4–3

**NOTE: This standard defines a pin rotation only. The package details, dimension and pin count, are not defined at this time.**

### 3.11.4.4 – 256K BY 32 SDRAM IN QFP or TQFP

CAPACITY—256K WORDS OF 32 BITS
LOGIC FEATURES—Multiplexed Address
—Synchronous address & control interface.
PACKAGE—100 PIN QFP or TQFP, 20 mm X 14 mm, 0.65 mm PP
PIN ASSIGNMENTS—FIG. 3.11.4–4

NOTE: This part has the same pinout as the SDRAM part shown in Fig. 3.10.3–4 with the exception of the DSF function on P 33.

### 3.11.4.5 – 2M BY 32 SDRAM IN TSOP2

**CAUTION:** See note in Fig. 3.11.4–5 regarding the use of this device.
CAPACITY—2M WORDS OF 32 BITS
LOGIC FEATURES—Multiplexed Address
—Synchronous address & control interface.
PACKAGE—84 PIN TSOP2, 10.16 mm WIDE, 0.5 mm PP
PIN ASSIGNMENTS—FIG. 3.11.4–5

### 3.11.4.6 – 8M BY 32 SDRAM IN TSOP2 PIN ROTATION

CAPACITY—8M WORDS OF 32 BITS
LOGIC FEATURES—This device will contain all of the logic features described in Sec. 3.11.5
—This standard is for a 4 Bank version only.
PACKAGE—TSOP2, PIN COUNT AND DIMENSIONS NOT DEFINED
PIN ASSIGNMENT—Fig. 3.11.4–6

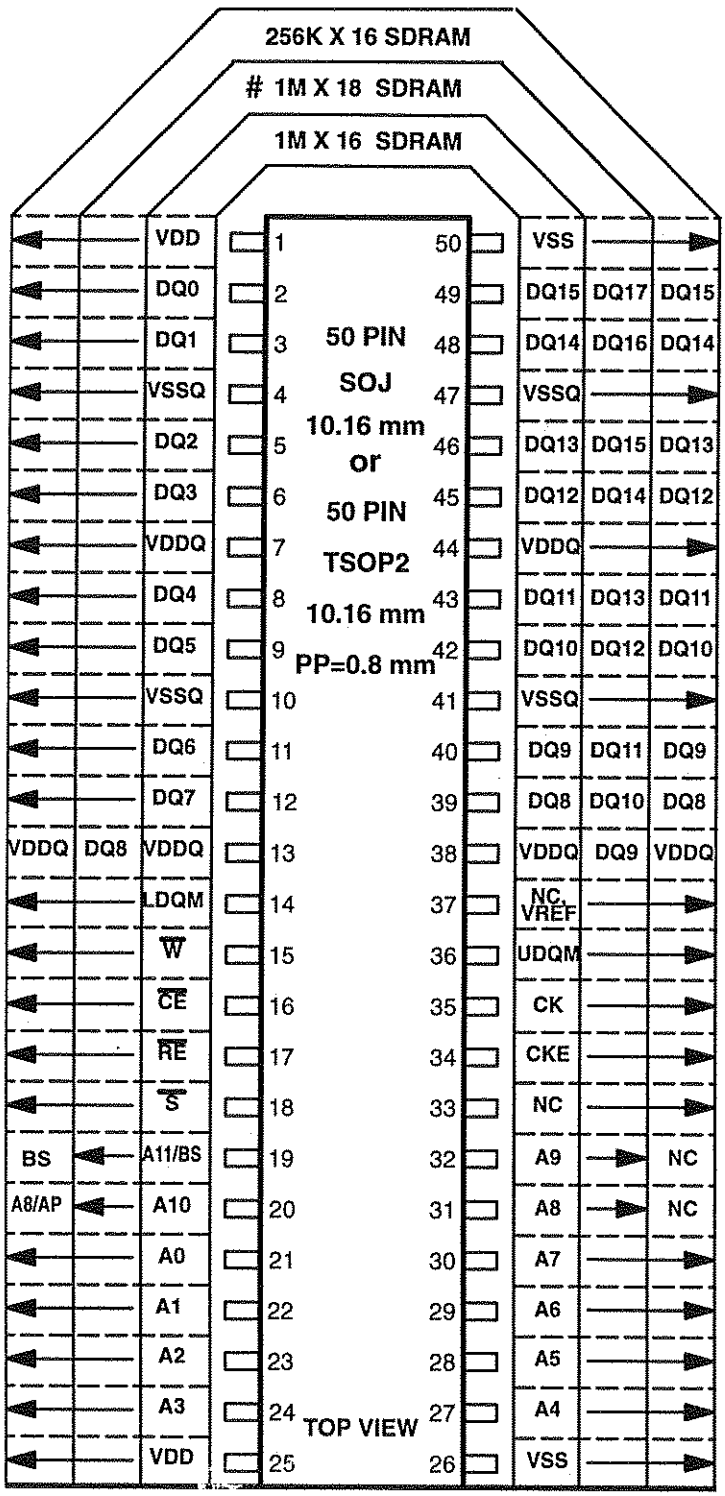
**NOTE: This standard defines a pin rotation only. The package details, dimension and pin count, are not defined at this time.**

### 3.11.4.7 – 2M BY 32 & 36 SDRAM IN TSOP2

CAPACITY—8M WORDS OF 32 BITS
LOGIC FEATURES—This device will contain all of the logic features described in Sec. 3.11.5
—This standard is for a 4 Bank version only.
PACKAGE—86 PIN TSOP2, 10.16 mm Wide, 0.5 mm PP
PIN ASSIGNMENT—Fig. 3.11.4–7



XILINX EXHIBIT 1012
Page 152




| | 256K | 1M 1K RFSH | 1M 4K RFSH |
|---|---|---|---|
| ROW/REFRESH ADDRESSES | A0 ⇒ A8 | A0 ⇒ A9 | A0 ⇒ A11 |
| COLUMN ADDRESSES | A0 ⇒ A7 | A0 ⇒ A9 | A0 ⇒ A7 |

* Note: The JEDEC Standard 30 term for the TSOP–2 package is PDSO–G

1) Pin 20 (A10) id the auto–precharge input during read and write commands.

2) Pin 37 (NC, VREF) is VREF on devices that need an external voltage reference. On other devices, it is a NC.

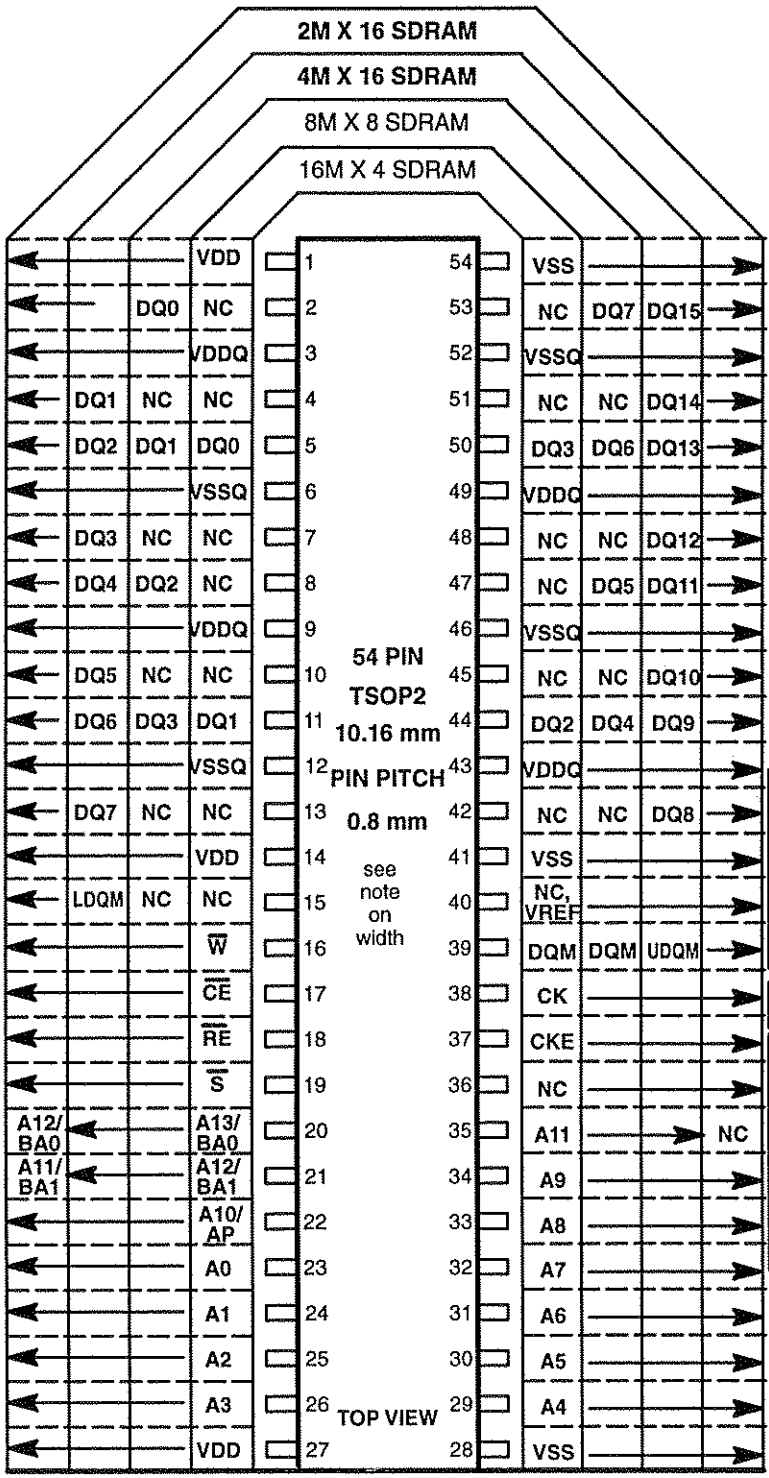
3) All VDDQ and VSSQ pins may be VDD and VSS at the option of the supplier

4) BS is the Bank Select Address

5) The 256K device has the same pinout as the 256K X 16 SGRAM shown in Fig 3.10.3–3 except for the lack of a DSF function on pin 33.

\# The 1M X 18 device is approved for use in the TSOP2 package only.

## FIGURE 3.11.4–1
## 256K X 16 & 1M X 16/18 SDRAM IN SOJ & TSOP–2




| Device | ROW ADDR. | COL ADDR |
|---|---|---|
| X4 | A0⇒A13 | A0⇒A9 |
| X8 | A0⇒A13 | A0⇒A8 |
| X16, 4M | A0⇒A13 | A0⇒A7 |
| X16, 2M | A0⇒A12 | A0⇒A7 |

| | |
|---|---|
| A10 | AUTO PRECHARGE |

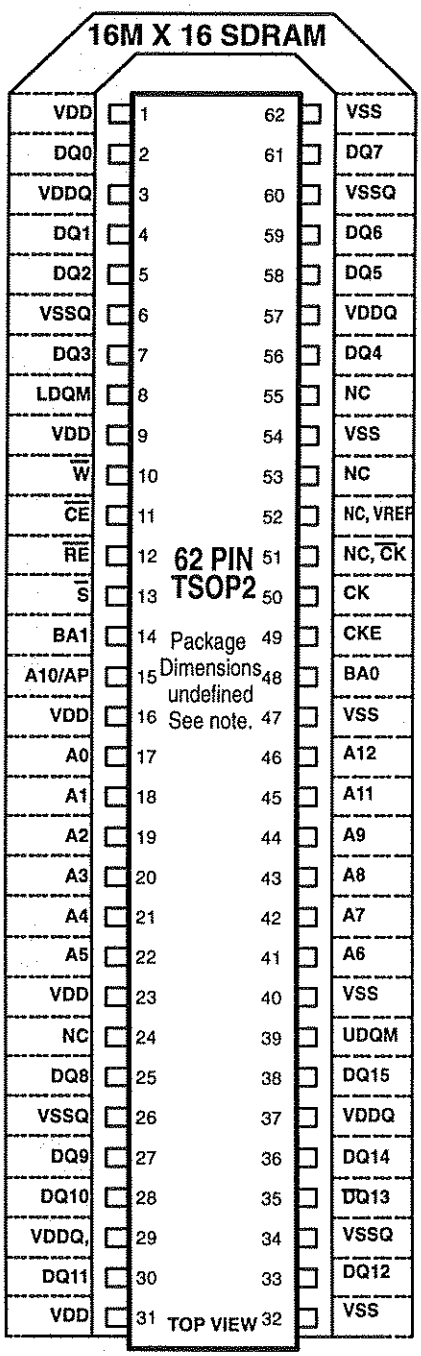
| BANKS | BANK SELECT ADDRESS |
|---|---|
| 4 | A13/A12 |
| 4 # | A12/A11 |
| 2 | A13 |
| 2 # | A12 |

# 2M X 16

* PACKAGE NOTES:

The JEDEC Std. 30 term for the TSOP–2 package is PDSO–G.

## FIGURE 3.11.4–2
## 2M & 4M BY 16 SDRAM IN TSOP2




| Configuration | 16M X 16 |
|---|---|
| ROW ADDRESS | A0–A12 |
| COLUMN ADDRESS | A0–A8 |

NOTES

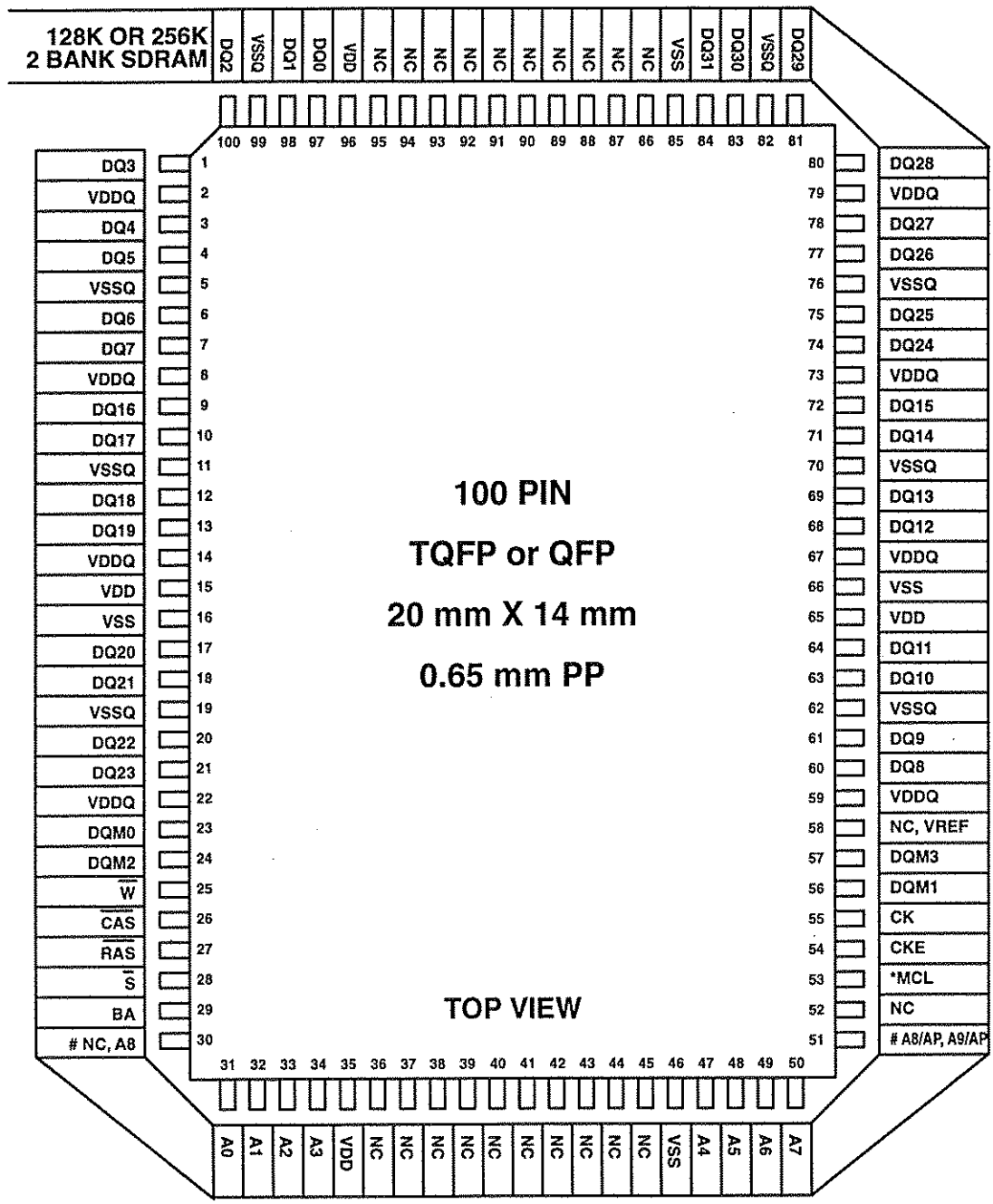
**1. Pin numbers and pin count are for reference only. This is a pin rotation only. Package dimensions are not specified at this stage.**

2. The standard refresh interval (tREF) for 256Mb SDRAMs is 64ms.
3. (NC, VREF) is VREF on devices that require an external voltage reference.
4. BA0 is the least significant bank address
5. BA1 is the most significant bank address
6. A10/AP is row address A10, autoprecharge and precharge all banks.
7. (NC, $\overline{CK}$) is NC for devices using a single ended clock. $\overline{CK}$ is used for devices using a differential clock.
8. (NC, VREF) is VREF on devices that require an external voltage reference.
9. This standard is for a 4 Bank version only.

* NOTE: The JEDEC Std. 30 term for the TSOP–2 package is PDSO–G.

**Pin numbers and pin count are for reference only. This is a pin rotation only. Package dimensions are not specified at this stage.**

## FIGURE 3.11.4–3
## 16M BY 16 SDRAM PIN ROTATION IN TSOP2




# Note: This pinout is for both 128K and 256K parts. The Pin assignments are as follows

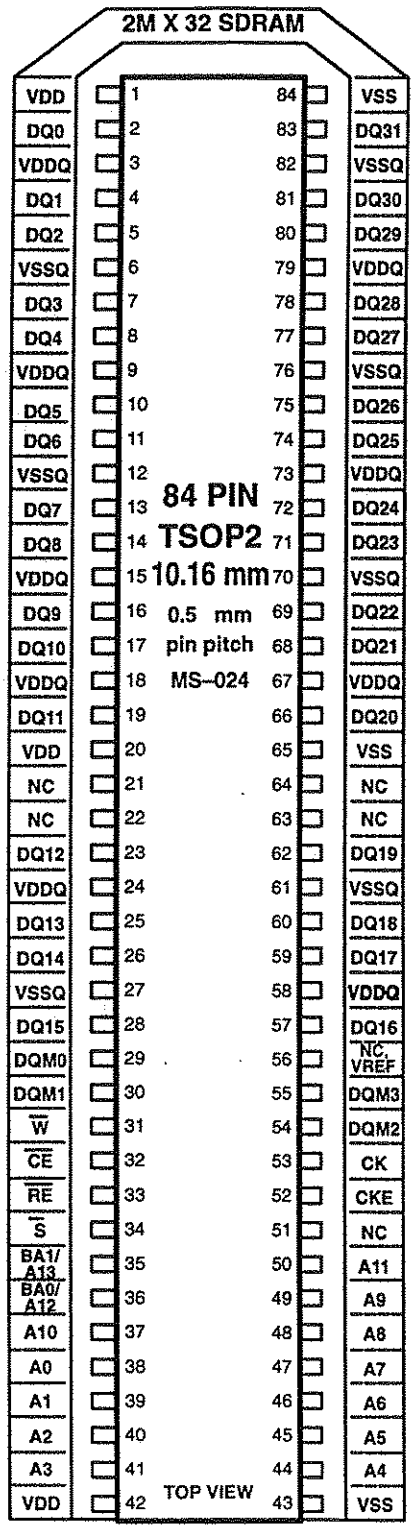
| Configuration | P30 | P51 |
|---|---|---|
| 128K x 2 Bank | NC | A8/AP; |
| 256K X 2 Bank | A8 | A9/AP |

* Note: This part is a subset of the SGRAM shown in Fig. 3.10.3–4. P53 is DSF for the SGRAM version and MCL for the SDRAM.
**MCL = Must Connect to Logic Low**

| Configuration | 128K X 2 | 256K X 2 |
|---|---|---|
| ROW ADDRESS | A0⇒A8,BA | A0⇒A9,BA |
| COLUMN ADDRESS | A0⇒A7 | A0⇒A7 |
| BANK SELECT | | A9 |
| REFRESH PERIOD | 16 ms | 32 ms |
| # ROWS REFRESH | 1024 | 2048 |

## FIGURE 3.11.4–4
## 128K & 256K BY 32, 2 BANK SDRAM IN QFP

**Release 6r7**



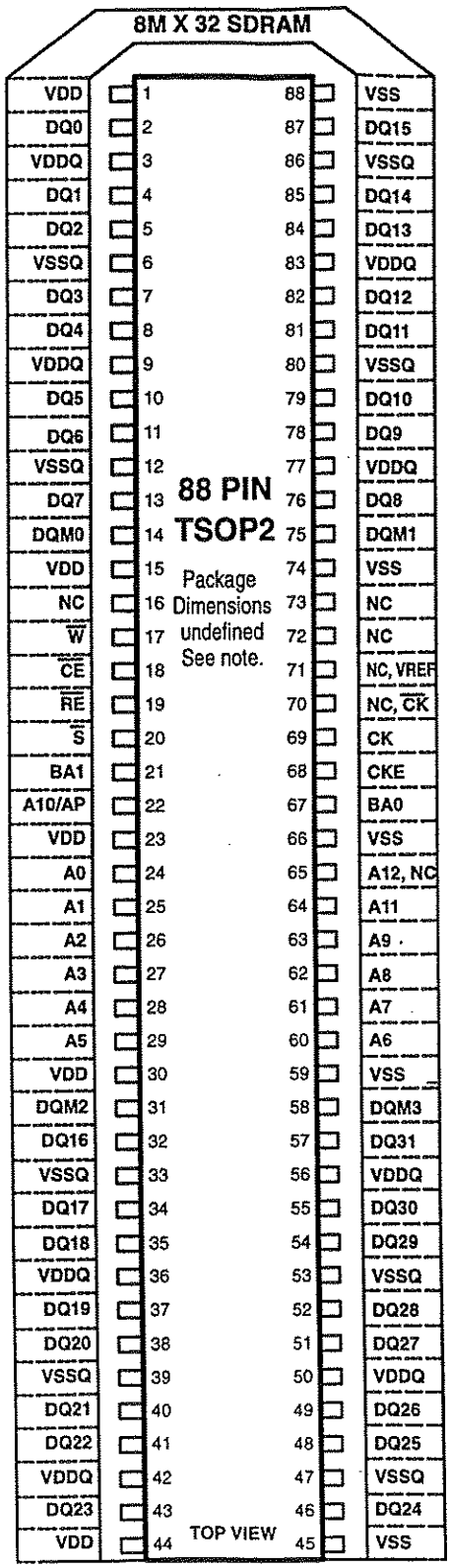

NOTE:
In addition to this pinout for a 2M X 32 SDRAM, there is another one that has the DQ pins at the outer ends of the package and the control pins in the center and superceeds this one. The other device should be used for all new designs. It is found in figure 3.11.4–7.

The JEDEC Std. No. 30 designator for the TSOP2 package is PDSO–G

**ADDRESS ORGANIZATION**

| | 2 | 4 |
|---|---|---|
| NUMBER BANKS | | |
| ROW ADDR. | A0⇒A13 | A0⇒A13 |
| COL. ADDR. | A0⇒A6 | A0⇒A6 |
| AUTO–PRECHARGE | A10 | A10 |
| BANK ADDRESS | A13 | A12, A13 |

**FIGURE 3.11.4–5**
**2M BY 32 SDRAM IN TSOP2**




NOTES
**1. Pin numbers and pin count are for reference only. This is a pin rotation only. Package dimensions are not specified at this stage.**
2. The standard refresh interval (tREF) for 256Mb SDRAMs is 64ms.
3. (NC, VREF) is VREF on devices that require an external voltage reference.
4. BA0 is the least significant bank address
5. BA1 is the most significant bank address
6. A10/AP is row address A10, autoprecharge and precharge all banks.
7. (NC, $\overline{CK}$) is NC for devices using a single ended clock. $\overline{CK}$ is used for devices using a differential clock.
8. (NC, VREF) is VREF on devices that require an external voltage reference.
9. This standard is for a 4 Bank version only.

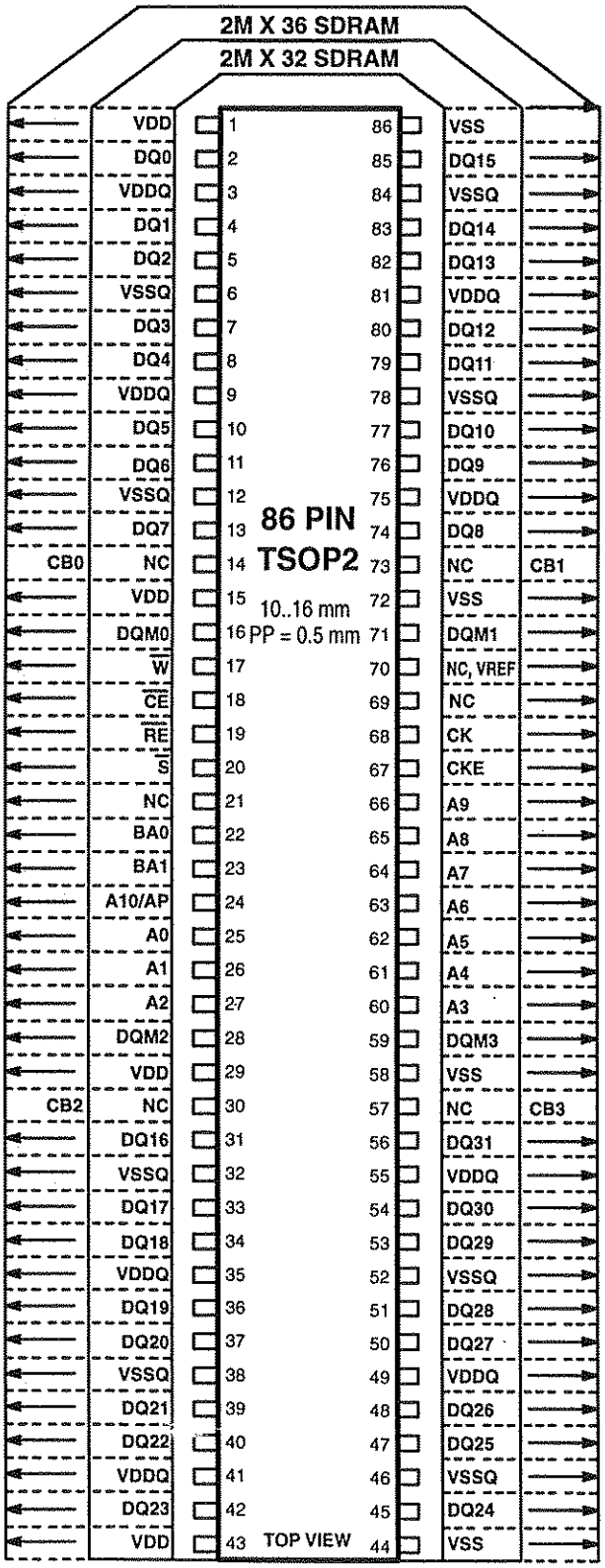
The JEDEC Std. No. 30 designator for the TSOP2 package is PDSO–G

| Configuration | 8M X 32 | 8M X 32 |
|---|---|---|
| Number RA | 13 | 12 |
| ROW ADDRESS | A0⇒A12 | A0⇒A11 |
| COLUMN ADDRESS | A0⇒A7 | A0⇒A8 |

**Pin numbers and pin count are for reference only. This is a pin rotation only. Package dimensions are not specified at this stage.**

## FIGURE 3.11.4–6
## 8M BY 32 SDRAM PIN ROTATION IN TSOP2

**Release 6c7**




NOTES

1. A10/AP Is Row Address A10, Autopre charge And Precharge All Banks Input.

2. (NC,VREF) is VREF on devices that require an external voltage reference.

3. The VDDQ designator is used when t power supply pins for the DQ I/O drivers are internally DC isolated from the VDD power supply pins.

4. The VSSQ designator is used when tl ground reference pins for the DQ I/O drivers are internally DC isolated from th primary ground reference (VSS) power supply pins.

The JEDEC Std. No. 30 designator for the TSOP2 package is PDSO–G

| Configuration | 2M X 32 |
|---|---|
| REFRESH ADDR. | A0 ⇒ A11 |
| ROW ADDRESS | A0 ⇒ A11 |
| COLUMN ADDRESS | A0 ⇒ A8 |

**FIGURE 3.11.4–7**
**2M BY 32 & 36 SDRAM IN TSOP2**

## SDRAM FUNCTION TRUTH TABLE for CKE

| CURRENT STATE | $CKE_{n-1}$ | $CKE_n$ | $\overline{S}$ | $\overline{RE}$ | $\overline{CE}$ | $\overline{W}$ | An | ACTION |
|---|---|---|---|---|---|---|---|---|
| Self–refresh[6] | H | X | X | X | X | X | X | INVALID |
| | L | H | H | X | X | X | X | EXIT Self–Refresh⇒ ABI |
| | L | H | L | H | H | H | X | EXIT Self–Refresh⇒ ABI |
| | L | H | L | H | H | L | X | ILLEGAL |
| | L | H | L | H | L | X | X | ILLEGAL |
| | L | H | L | L | X | X | X | ILLEGAL |
| | L | L | X | X | X | X | X | NOP (Maintain Self–Refresh) |
| Power–Down | H | X * | X | X | X | X | X | INVALID |
| | L | H * | H | X* | X* | X* | X | EXIT Power Down⇒ABI |
| | L | H * | L | H | H | H | X | EXIT Power Down⇒ABI |
| | L | H * | L | H | H* | L* | X | ILLEGAL |
| | L | H * | L | H* | L* | X* | X | ILLEGAL |
| | L | H* | L | L | X* | X* | X | ILLEGAL |
| | L | L | X | X* | X* | X | X | NOP(Maintain Low–Power Mode) |
| All Banks Idle[7] | H | H | X | X | X | X | X | Refer to Table 1 |
| | H | L | H | X | X | X | X | Enter Power–Down |
| | H | L | L | H | H | H | X | Enter Power–Down |
| | H | L | L | H | H | L | X | ILLEGAL |
| | H | L | L | H | L | X | X | ILLEGAL |
| | H | L | L | L | H | X | X | ILLEGAL |
| | H | L | L | L | L | H | X | Enter Self–Refresh |
| | H | L | L | L | L | L | X | ILLEGAL |
| | L | L | X | X | X | X | X | NOP |
| Any State other than listed above | H | H | X | X | X | X | X | Refer to operations Table 1 |
| | H | L | X | X | X | X | X | Begin Clock Suspend next cycle[8] |
| | L | H | X | X | X | X | X | Exit Clock Suspend next cycle[8] |
| | L | L | X | X | X | X | X | Maintain Clock Suspend. |

ABBREVIATIONS
ABI = All Banks Idle
NOTES:

6. CKE Low–to–High transition will re–enable CK and other inputs asynchronously. A minimum setup time must be satisfied before any command other than EXIT.
7. Power–Down and Self–Refresh can be entered only from the All Banks Idle State.
8. Must be legal command.
* Elements of the table that were in error in the first printing of Release 4

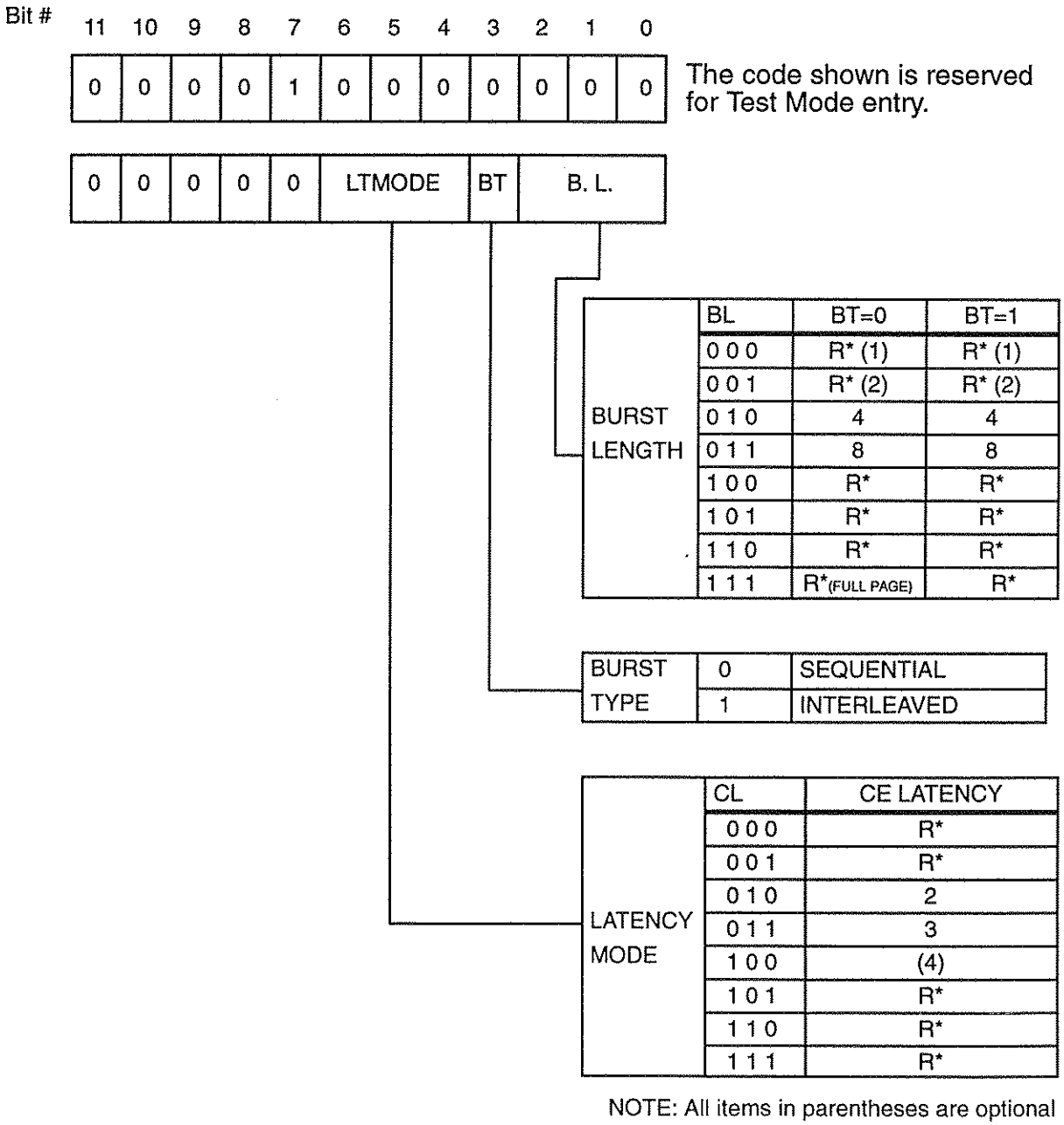
**TABLE1 3.11.5–2**

**SDRAM FUNCTION TRUTH TABLE for CKE**

## SDRAM Mode Register

This Mode Register is located on the Synchronous DRAM (SDRAM) chip. Its purpose is to store the mode–of–operation data. This data is written after power–on and before normal operation. The data contains the Burst Length, the Burst Type, the $\overline{CE}$ Latency, and whether it is to be operating in Test Mode, or Normal operating mode. During operation, this register (and therefore operation of the chip) may be changed, according to the requirements of the Mode–Register–Write Timing diagram. So, while operating in one mode, for example Burst of 4 in sequential addresses; it can change to Burst of 8 in Interleaved address mode.

SDRAM Mode Register architecture:




NOTE: All items in parentheses are optional

**FIGURE 3.11.5–1**
**SDRAM MODE REGISTER ARCHITECTURE**

### 3.11.5.4–Power On Sequence (Recommended)

The synchronous nature of the inputs and outputs of the SDRAM device create the possibility that a SDRAM device could power up in a state with data being driven out of the part, and in a multipart system, such a condition may cause data contention and possibly device damage in the long term. In an attempt to reduce the possibility of data contention, both system and device designers should strive toward ensuring a High–Z output state during the initial power up sequence. The following recommended power on sequence is offered for both system and device designers as a means to help the device power up with the outputs in a High–Z state.

The default power on value for the mode register is supplier specific and may be undefined.

The default power on value for the device is supplier specific and may be undefined.

The recommended power on sequence is as follows:

1. Apply power and start clock. Attempt to maintain a NOP condition at the inputs
2. Maintain stable power, stable clock, and NOP input conditions for a minimum of 200 μS.
3. Issue precharge commands for all banks of the device.
4. Issue 8 or more autorefresh commands.
5. Issue a mode register set command to initialize the mode register.

The device is now in the IDLE state and is ready for normal operation.

### 3.11.5.5–Auto Precharge

The user may specify that the bank currently being accessed precharge itself as soon as the burst is completed. This is done using address bit AP during the column address cycle. The following table defines the options available from AP during the column address portion of any cycle.

| AP | Option |
|---|---|
| 0 | Do not auto precharge, leave bank active at end of burst. |
| 1 | Auto precharge bank specified by BA at end of burst. |

The user must wait until the precharge is completed before issuing another command to the device. Timing for auto precharge is required to be the same as or less than the minimum requirement of external precharge.

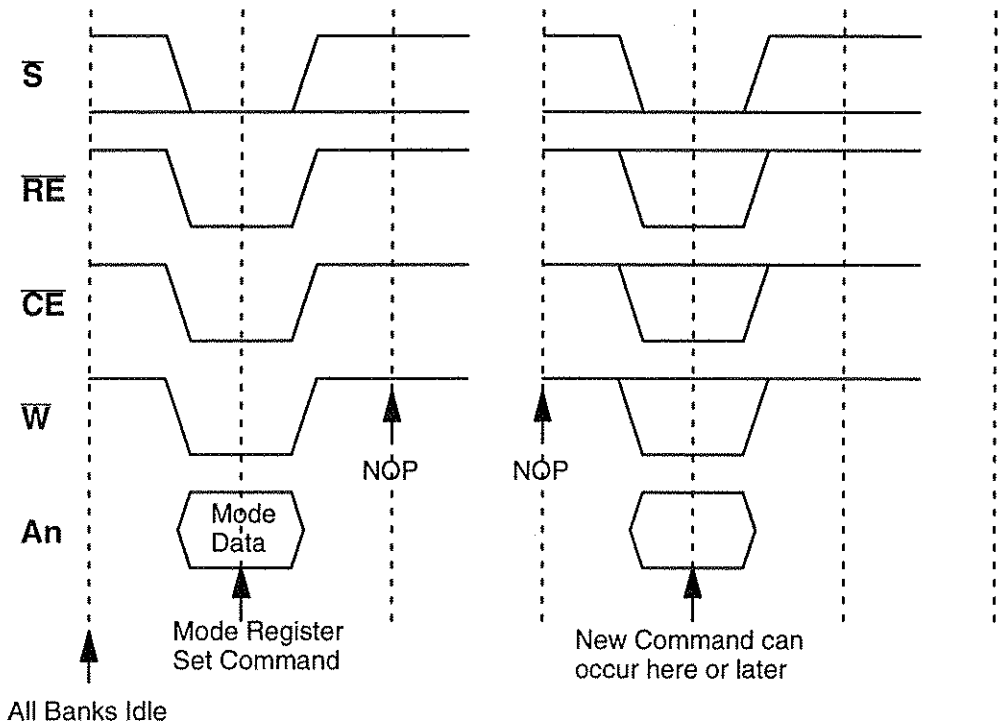
### 3.11.5.6–Precharge All Banks

The user may specify, during a precharge command, whether to precharge only the specified bank or to precharge all banks. BA is used to specify the bank to be precharge, and AP is used to indicate the precharge option. The following table defines the options available from AP during the precharge cycle.

| PA | Option |
|---|---|
| 0 | Precharge bank specified by BA |
| 1 | Precharge All banks |

### 3.11.5.7–Mode Register Write Timing

The Mode Register Set Cycle is initiated by holding the $\overline{S}$, $\overline{RE}$, $\overline{CE}$, and $\overline{W}$ signals low at the clock rising edge. The address lines at the same clock edge contain the mode register set opcode and the valid mode information to be written into the mode register. A mode register set cycle can be followed by a new command in no less than 3 clock cycles as illustrated in the diagram below.




Note: Clock Low–to–high transitions occur at the dotted lines.

# 4 MEMORY MODULES AND CARDS

The following standards for MODULES and CARDS were developed by Committee JC–42.5. In earlier releases of JESD 21–C, the individual standards were intermixed and appeared in one section, 4, in the order in which they were approved with no regard for the module structure or organization. In Release 7, the section has been reorganized and the individual standards grouped in sub–sections by the data word length. A separate section is included (4.1) for those standards that describe features that are generic in nature and independent of the module organization.

The standards establish pin assignments for a series of multi–chip modules. The package configurations and dimensions are as defined in JEDEC Publication 95. The modules will normally be made using surface mount devices described in section 3 of this standard. The initial standards were for DRAM modules, but the since the publication of Std. 21–B, a standard for a families of SRAM and non–volatile modules have been approved. In addition to the device standards, there is a standard that addresses special nomenclature related to the modules.

The sub–sections are as follows:

4.1 Module & Card Features
4.2 One Byte Modules
4.3 Two Byte Modules and Cards
4.4 Four Byte Modules and Cards
4.5 Eight Byte Modules
4.6 Sixteen Byte Modules

## 4.1 Module Features & Properties

The following standards are applicable to modules and cards without regard to the data word length except as where specifically indicated.

### 4.1.1 Memory Module Nomenclature

### 4.1.2 Memory Module Serial Presence Detect (SPD) General Standard

#### 4.1.2.1 SPD Appendix A

#### 4.1.2.2 SPD Appendix B

#### 4.1.2.3 SPD Appendix C

#### 4.1.2.4 SPD Appendix D

#### 4.1.2.5 SPD Appendix E

#### 4.1.2.6 SPD Appendix F

## 4.1.1 Memory Module Nomenclature

### 4.1.1.1 – Purpose

The purpose of this standard is to establish a format for a number system which defines the format of a number which is an architectural description of multi–chip memory modules. It is intended to be used with but not restricted to modules made with DRAM devices.

### 4.1.1.2 – Number Format

The description number designation shall consist of 8 fields with the form nnSccbbDttlpp where :
nn = the number of longitudinal positions on the module: 4, 5, 8, 9.
S = the number of sides on the module stated as "single or double" : S, D
cc = the capacity of the memory chip stated in terms of the log(2) of the capacity (i.e.–the number of address bits needed for the chip): 16, 18, 20, 22
bb = the number of data bits in the interface: 1, 2, 4, 5, 8, 9, 10, 17
D = the data interface configuration, common, separate, or mixed: C, S, M
tt = total number of words stated as log(2) of the capacity: 16—26
l = mechanical interface: P = pins, E = edge card connector
pp = number of pins or pads

### 4.1.1.3 – Number Example

A module with the following attributes:
9 chips long
Double sided
18 bit data interface
Separate I/O for parity bits, common I/O for other bits
1M X 1 memory chips
Pin interface
Architectural number: 9D2018M20P40



XILINX EXHIBIT 1012
Page 169

# 4.1.2 – SERIAL PRESENCE DETECT STANDARD, General Standard

Introduction: New memory technologies are continually being introduced to the industry. As these new technologies are considered, the need for expansion modules becomes evident; consequently, new memory technologies are being incorporated onto existing module form factors. Unfortunately, upon a module's first implementation, the module designer is often unable to predict all of the (as yet unreleased) memory technologies which would eventually be used on the module form factor; hence the parallel Presence Detect method did not allow for these newer technologies. Given that memory modules do not regularly change form factor when a new memory technology is implemented, a Serial Presence Detect (SPD) method should be available and predefined so that it can be considered for new memory modules when needed.

1 **Scope:** This standard defines the means to implement a Presence Detect (PD) scheme serially. This Serial Presence Detect (SPD) standard is intended for use on any memory module independent of memory technology or module form factor. At the point of standardization of any given memory module, SPD being defined within this standard, may be easily implemented if so chosen. The body of this standard will depict generally how SPD is implemented; this will be independent of the module's memory technology.

When a specific memory technology is being depicted (e.g. Fast Page Mode DRAM), an appendix to this standard will be added describing the characteristics, features, and attributes of that memory technology needed for Presence Detection. The entire address map of the SPD scheme must be presented in each appendix.

When a new module form factor implementing SPD is standardized, the (proposed) standard for that module must also include the following information pertinent to the SPD:

- SPD Interface protocol (see section 2 herein)
- Acceptable module configurations,
- Legitimate architectures: depth, width, #banks, addressing
- Acceptable error checking schemes (ECC, Parity...)
- SPD Wiring diagram and pinout to module.

2 **Interface Protocol.** Upon the development/standardization of a new module form factor incorporating SPD, the SPD interface protocol will be defined. As long as that module form factor is used, this protocol must remain constant. Examples of SPD interface protocol include IIC, Microwire, etc. The physical implementation (pinouts etc.) must also be defined in the standard for the module form factor if it implements SPD.

3 **Data Order and PD Size:** This document will present the order in which the PD bytes should follow. It also defines how many bytes must be used to define a given PD; in most cases it will be one byte per PD. The SPD address map is fixed upon selection of any given fundamental technology, this includes all required and optional data; when a fundamental memory technologies' PD bits are defined, then the entire address map for those SPDs must also be defined.

4 **SPD Data Types:** SPD data is stored in a non–volatile serial memory device. The different types of data include, but are not limited to:

- Look Up Table entries
- Binary data
- Optional data (Binary, ASCII, etc. data)
- Checksums

4.1 **Look Up Table (LUT) Entries:** Much of the SPD data is organized as a series of table entries. Each table entry contains one or more bytes of information. Each table entry represents one particular characteristic pertinent to the memory module; e.g. fast page mode DRAM will have specific tables for tRAC, tCAC, # of banks, number of row addresses, number of column addresses, error detection/correction, refresh rates, data width, and interface standard. Each table entry corresponds to a position on a look–up– table specified within an appendix within this standard. The number of bytes (one or more) needed to express a particular aspect of the module is fixed and defined in this standard or in one of its appendices.

4.2 **Optional Data:** The current Jedec Standard allows for manufacturers to insert some of their own specific data into the SPD ROM. This data includes manufacturer ID, manufacturers' module serial numbers, and other ASCII, Binary Coded Decimal, or binary data.

4.3 **Checksums:** In various cases, checksums are required. Checksum calculation method is currently being proposed at time of publication of this standard.



XILINX EXHIBIT 1012
Page 171

5 **SPD Content:** The Serial Presence Detect standard calls for various features and items to be defined. Specifically, the following must be addressed in any SPD implementation:

| Description | Data Type | Address Map Byte # |
|---|---|---|
| SPD size | LUT Entry | 0 |
| Total SPD memory size | LUT Entry | 1 |
| Fundamental memory type | LUT Entry, Appendix A | 2 |
| Definition of features specific to the fundamental memory | See pertinent appendix | 3–31 |
| (Optional) Superset memory type | See appendix B | 32 |
| (Optional) definition of features specific to the superset memory | See pertinent appendix | 33–61 |
| SPD Revision designator | LUT | 62 |
| Checksum for bytes 0–62 | Checksum | 63 |
| Manufacturers Jedec ID code per JEP–106 | LUT | 64–71 |
| Manufacturing location | Supplier Unique | 72 |
| Manufacturer's Part Number | Supplier Unique | 73–90 |
| Revision Code | Supplier Unique | 91–92 |
| Manufacturing date | BCD | 93–94 |
| Assembly Serial Number | Supplier Unique | 95–98 |
| Manufacturer Specific Data | Supplier Unique | 99–125 |
| Reserved | N/A | 126–127 |
| Open free–form area | Application Specific | 128–255 |

Detailed descriptions follow in paragraphs 5.x

5.1 **Byte 0,** Number of Bytes used by Module Manufacturer: This field describes the total number of bytes used by the module manufacturer for the SPD data and any (optional) specific supplier information. The byte count includes the fields for all required and optional data:

| Number SPD Bytes | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 10 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 11 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 12 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| | . | . | . | . | . | . | . | . |
| | . | . | . | . | . | . | . | . |
| 127 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 128 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | . | . | . | . | . | . | . | . |
| | . | . | . | . | . | . | . | . |
| 254 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 255 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

5.2 **Byte 1, Total SPD Memory Size:** This field describes the total size of the serial memory (often an EEPROM) used to hold the Serial Presence Detect data. The following lookup table describes the possible serial memory densities (in bytes) along with the corresponding descriptor:

| Serial Memory Density | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| RFU | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 Bytes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 4 Bytes | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 8 Bytes | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 16 Bytes | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 32 Bytes | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 64 Bytes | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 128 Bytes | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 256 Bytes | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 512 Bytes | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 1024 Bytes | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 2048 Bytes | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 4096 Bytes | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 8192 Bytes | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 16284 Bytes | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| . | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| . | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

5.3 **Byte 2,** Fundamental Memory Type: This field will identify the fundamental type of memory. The fundamental type of memory may include Fast Page Mode DRAM, EDO DRAM, Masked ROM, EEPROM, Synchronous DRAM, etc. The table listing all the types of Fundamental memory is contained in **appendix A** herein. New fundamental types can be added to this table anytime after standardization of a fundamental memory type. Note that if a given new technology is completely backward compatible with pre–existing technology, then it should be considered a Superset technology and so described as detailed (in paragraph 5.5) within this standard.

5.4 **Bytes 3–31:** Descriptions of Module Specific Features: Appendices to this standard detail the tables for the features specific to each of the fundamental memory types as described above. For example, see appendix C for details of SPD features for Fast Page Mode and Extended Data Out DRAM Modules.

5.5 **Byte 32:** Superset Memory Type: When a new technology is developed which is completely backward compatible to an already specified (fundamental) technology, then it may be considered a $Superset' technology. The benefits of specifying a technology as a superset are obvious; if a system is capable of operating in a $fundamental' mode only and a superset module is inserted, then the system can still use the module. The memory superset type or technology is specified in appendix B to this standard. Appendix B provides the decode of specific superset technologies. It references other appendices where the specific superset PDs are further detailed. As new supersets are created, appendices must also be added. Presence Detects for a superset technology are specified just as for any given fundamental technology except that any and all backward compatible fundamental technologies must be referenced.

5.6 **Bytes 33–63:** Superset Features: Appendices to this standard detail the tables for the features specific to each of the superset memory types as described above. A new appendix must be added to this standard detailing the PDs for that superset technology detailed in appendix B and represented in byte 32. Appendix B would identify the superset technology type and would also reference the appropriate appendix where the superset is detailed.

5.9.0 **Bytes 64–127:** Module manufacturers may include information which is pertinent to their particular modules. This information is detailed below in paragraph 5.9.X:

5.9.1 **Bytes 64–71**: Manufacturers Jedec ID code per JEP106. Manufacturers of a given module may include their identifier per Jedec spec JEP106. 00h is not allowed and FF indicated continuation. The first byte is utilized, the second byte filling. Unused locations/bytes would be FFh.

5.9.2 **Byte 72:** Manufacturing Location. Manufacturers may include an identifier which uniquely defines the manufacturing location of the memory module. While the SPD spec will not attempt to present a decode table for manufacturing sites, the individual manufacturer may keep track of manufacturing location and its appropriate decode represented in this byte.



XILINX EXHIBIT 1012
Page 173

5.9.3 **Bytes 73–90:** Manufacturer's Part Number: Manufacturers may include their part number in 6–bit ASCII format within these bytes.

5.9.4 **Bytes 91–92:** Revision Code: This refers to the module revision code. While the SPD spec will not attempt to define the format for this information, the individual manufacturer may keep track of the revision code and its appropriate decode represented in this byte.

5.9.5 **Bytes 93–94:** Date of Module Manufacture: The module manufacturer may include a date code for the module. If this is done, then specifically, byte 93 must contain the year in Binary and byte 94 must contain the week in Binary.

5.9.6 **Bytes 95–98:** Module Serial Number: The supplier may include a serial number for module. The supplier may use whatever decode method desired to maintain a unique serial number for each module.

5.9.7 **Bytes 99–125:** Manufacturers specific data, open area. The module manufacturer may add any additional information desired into the module within these locations.

5.9.8 **Bytes 126–127:** Reserved. These bytes are reserved and cannot be later allocated.

5.10 **Bytes 128–255:** System Integrators specific information: The system integrator may choose to use the SPD ROM for various items. If so, then bytes 128–255 may be used.



XILINX EXHIBIT 1012
Page 174

# 4.1.2.1 – Appendix A: Table of Fundamental Memory Types:

This table is modified/appended whenever a new fundamental memory technology is to be added to the Serial Presence Detect (SPD) standard. When a new memory type is added to this standard, a new appendix must also be added which details the specific features pertinent to the new fundamental type. The following table details the fundamental memory types.

**Byte 2, Fundamental Memory Type:** This field identifies the fundamental type of memory. The fundamental type of memory may include Fast Page Mode DRAM, EDO DRAM, Masked ROM, EEPROM, Synchronous DRAM, etc. The table listing all the types of Fundamental memory is contained in this Appendix herein. New fundamental types can be added to this table anytime after standardization of a fundamental memory type. Note that if a given new technology is completely backward compatible with pre–existing technology, then it should be considered a Superset technology and so described as detailed (in paragraph 5.5 of the General Standard) within this standard.

The fundamental memory types are identified as follows:

| Fundamental Mem. Type | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 | See Appndx |
|---|---|---|---|---|---|---|---|---|---|
| Reserved | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| Standard FPM DRAM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | C |
| EDO | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | C |
| PNEDO | | | | | | | | | |
| | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | TBD |
| Sync Dram | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | E |
| Multiplexed ROM | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | F |
| TBD | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | TBD |
| . | . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . | . |
| TBD | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | TBD |
| TBD | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | TBD |
| TBD | | | | | | | | | |
| | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | TBD |

## 4.1.2.2 – Appendix B: Table(s) of Superset Memory Types:

This table is modified/appended whenever a new Superset memory technology is to be added to the Serial Presence Detect (SPD) standard. When a new superset memory type is added to this standard, a new appendix must also be added which details the specific features pertinent to the new superset type. The following table identifies the Superset memory types and their pertinent fundamental technologies.

The Superset memory types are identified as follows:

| Superset Mem. Type Appndx | Fundamental memory type. (note 1) | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 | See |
|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| TBD | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | TBD |
| TBD | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | TBD |
| TBD | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | TBD |
| TBD | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | TBD |
| TBD | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | TBD |
| TBD | | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | TBD |
| . | . | . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . | . | . |
| TBD | | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | TBD |
| TBD | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | TBD |
| TBD | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | TBD |

Note 1: The fully backward compatible Fundamental memory type must be referenced when a superset is specified.

# 4.1.2.3 – Appendix C: Specific PD's for Fast Page Mode or Extended Data Out DRAM.

1 **Introduction:** This appendix describes the Presence Detects for Fast Page Mode DRAM and Extended Data Out (EDO) DRAM Modules. These PD's are those referenced in the SPD standard as "Specific Features". The following PD fields will occur, in the order presented, at the point in the standard where the Specific Features are referenced; that is after the identification of the Fundamental Memory Type and before identification of whether there is any Superset Features presented. For convenience sake however, the complete address map is presented herein.

1.1 **Address map:** The following is the SPD address map for FPM and EDO. It describes where the individual LUT–Entries/bytes will be held in the serial EEPROM:

| Byte Number | Function described | Notes |
|---|---|---|
| 0 | Defines # bytes written into serial memory at module mfgr | 1 |
| 1 | Total # bytes of SPD memory device | 2 |
| 2 | Fundamental memory type (FPM, EDO, SDRAM...) from appendix A | |
| 3 | # Row Addresses on this assembly | 3 |
| 4 | # Column Addresses on this assembly | |
| 5 | # DRAM Banks on this Assembly | |
| 6 | Data Width of this assembly... | |
| 7 | ...Data Width continuation | |
| 8 | Voltage interface standard of this assembly | |
| 9 | RAS# access time of this assembly | 4 |
| 10 | CAS# access time of this assembly | 4 |
| 11 | DIMM Configuration type (Non–parity, Parity, ECC) | |
| 12 | Refresh Rate/Type | 4,5 |
| 13 | DRAM width, Primary DRAM | |
| 14 | Error Checking DRAM data width | |
| 15–31 | Reserved for future offerings | |
| 32 | Superset Memory Type (may be used in future) | |
| 33–62 | Superset Memory Specific Features (may be used in future) | |
| 63 | Checksum for bytes 0–62 | |
| 64–71 | Manufacturers JEDEC ID code per JEP–106 | 6 |
| 72 | Manufacturing location | 6 |
| 73–90 | Manufacturer's Part Number | 6 |
| 91–92 | Revision Code | 6 |
| 93–94 | Manufacturing date | 6 |
| 95–98 | Assembly Serial Number | 6 |
| 99–125 | Manufacturer Specific Data | 6 |
| 126–127 | Reserved | |
| 128–255 | Open User Free–Form area$not defined | |

notes:

1) This will be 128 bytes for FPM and EDO DRAM

2) This will be 256 bytes, represented as 08h. See below.

3) High order bit defines is assembly has "redundant" addressing (if set to "1", highest order RAS# address must be re–sent as highest order CAS# address.)

4) From data sheet.

5) High order bit (MSB) is Self Refresh $flag'. If bit seven is "1", assembly supports self refresh.

6) Per the JEDEC spec, these are optional.

2 **Bytes 0–2,** For Reference: Descriptions of bytes 0–1 can be found in the main body of the SPD standard, and byte 2 is detailed in **appendix A** to this standard. For reference and convenience, applicable portions of their descriptions are presented again:

2.1 **BYTE 0,** From General SPD Standard, Number of Bytes used by Module Manufacturer: This field describes the total number of bytes used by the module manufacturer for the SPD data and any (optional) specific supplier information. The byte count includes the fields for all required and optional data.

| Number SPD Bytes | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 10 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 11 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 128 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 254 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 255 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

2.2 **Byte 1,** From General SPD Standard, Total SPD Memory Size: This field describes the total size of the serial memory used to hold the Serial Presence Detect data. The following lookup table describes the possible serial memory densities (in bytes) along with the corresponding descriptor:

| Serial Memory Density | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| RFU | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 Bytes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 4 Bytes | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 8 Bytes | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 16 Bytes | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 32 Bytes | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 64 Bytes | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 128 Bytes | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 256 Bytes | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 512 Bytes | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 1024 Bytes | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 2048 Bytes | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 4096 Bytes | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 8192 Bytes | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 16284 Bytes | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| . | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| . | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

2.3 **Byte 2,** From Appendix A, Memory Type: This byte describes the fundamental memory type (or technology) implemented on the module:

| Fundamental Mem. Type | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Reserved | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Standard FPM DRAM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| EDO | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |

3 **Data Type(s):** Even though many of the PD's seem to be binary numbers representing the feature they are describing, they are considered Look Up Table (LUT) entries.

4 The following PD bytes are those specific to modules implementing Fast Page Mode and EDO DRAM technology. Note that full descriptions start at byte 3 and are not covered in the main body of the SPD standard since they are specific to a given fundamental memory type/technology.

4.1 **Byte #3, Number of ROW Addresses:** This first field describes the number of Row Addresses in the DRAM array:

| No. of Row Addresses | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 10 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 11 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 12 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 127 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Undefined | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| 12(redundant) | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 13(redundant) | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 126(redundant) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 127(redundant) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

Bit7: "0" indicates normal addressing; "1" indicates redundant addressing

4.2 **Byte #4, Number of COLUMNe Addresses:** This field describes the number of COLUMN addresses in the module's DRAM array:

| Number of COLUMN Addresses | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 10 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 11 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 12 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 14 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| | . | . | . | . | . | . | . | . |
| | . | . | . | . | . | . | . | . |
| 254 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 255 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

4.3 **Byte #5, Number of Banks:** This field describes the number of banks on the DRAM Module:

| Number of Banks | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 10 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 11 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 12 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 14 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| | . | . | . | . | . | . | . | . |
| | . | . | . | . | . | . | . | . |
| 254 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 255 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

4.4 **Bytes 6 & 7,** Module Data Width: Bytes 6 and 7 are used to designate the modules data width. The data width is presented as a 16 bit word; bit 0 of byte 6 becomes the LSB of the 16 bit width identifier and bit7 of byte 7 becomes the MSB. Consequently, if the module has a width of less than 255 bits wide, byte 7 will be 00h. If the data width is 256 bits or higher, byte 7 is used in conjunction with byte 6 to designate the total module width. For example, if the module's

| data width is: | then byte 7 is | and byte 6 is: |
|---|---|---|
| 64 | 0000 0000 | 0100 0000 |
| 72 | 0000 0000 | 0100 1000 |
| 576 | 0000 0010 | 0100 0000 |

**Byte 6:**

| Data Width | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 32 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| 36 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 64 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| 72 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 128 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| 144 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 254 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 255 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

4.4.1 **Byte 7, Module Data Width Continued:** This byte will be left at 00h if the original module data width is less than 256 bits wide. If the width is more than 255, then this byte will be used in conjunction with byte 6.

| Module Data Width Cont. | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| 0(+) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 256(+) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 512(+) | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 1024(+) | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 2048(+) | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |

4.5 **Byte 8, Module Interface Levels:** This field describes the module's voltage interface:

| Voltage Interface | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| 5.0 Volt/TTL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LVTTL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| HSTL 1.5 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| SSTL 3.3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| SSTL 2.5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| TBD | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| TBD | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| New Table | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |



XILINX EXHIBIT 1012
Page 183

4.6 **Byte 9, RAS Access Time (tRAC):** This field describes the module's RAS access time:

| RAS Access Time | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1ns | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2ns | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3ns | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 50ns | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 60ns | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 70ns | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 80ns | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| 254ns | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 255ns | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

4.7 **Byte 10, CAS Access Time (tCAC):** This field describes the module's CAS access time:

| CAS Access Time | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1ns | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2ns | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3ns | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 10ns | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 11ns | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 12ns | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 13ns | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 14ns | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| 15ns | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 16ns | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 17ns | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| 18ns | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| 19ns | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| 20ns | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| 21ns | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| 22ns | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| 23ns | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| 24ns | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 25ns | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 254ns | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 255ns | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

4.8 **Byte 11, Module Configuration type:** This field describes the module's error detection and or correction schemes:

| Error Det/Cor | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| None | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Parity | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| ECC | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| TBD | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| TBD | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| TBD | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| TBD | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| TBD | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

4.9 **Byte 12, Refresh Rate/Type:** This field describes the module's refresh rate and type:

| Refresh Period | Bit 7, Self Refresh Flag | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Normal (15.625 us) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced (.25x)...3.9us | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Reduced (.5x)...7.8us | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Extended (2x)...31.3us | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Extended (4x)...62.5us | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Extended (8x)...125us | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| TBD | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| TBD | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| TBD | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| TBD | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| Self Refresh Entries | | | | | | | | |
| Normal (15.625us) | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced (0.25x)...3.9us | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Reduced (0.5x)...7.8us | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Extended (2x)...31.3us | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Extended (4x)...62.5us | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Extended (8x)...125us | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| TBD | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| TBD | . | . | . | . | . | . | . | . |
| TBD | . | . | . | . | . | . | . | . |
| TBD | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| TBD | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**4.10 Byte 13, DRAM width, Primary DRAM:** This field describes the width of the primary DRAMs used on the module. The primary DRAM is that which is used for data; examples of primary (data) DRAM widths are x4, x8, x16, x32. Note that if the module is made with DRAMs which provide extra bits for data and error checking e.g. x9, x18, x36, then it is also designated in this field. Examples using x72 modules include:

| Module width | Primary Data DRAM Width | Error Checking DRAM Width | Qty Primary Data DRAMs | Byte 13 (Binary) |
|---|---|---|---|---|
| x72 | x9 | — | 8 | 0000 1001 |
| x72 | x8 | x8 | 9 | 0000 1000 |
| x72 | x16 | x1 | 4 | 0001 0000 |

| DRAM Width, Primary DRAM | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 15 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 16 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| 18 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| . | . | . | . | . | . | . | . | . |
| 32 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| 36 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 255 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**4.11 Byte 14, Error Checking DRAM data width:** If the module incorporates error checking and if the primary data DRAM does not include these bits; i.e. there are separate error checking DRAMs, then the error checking DRAM's width is expressed in this byte. Examples of error checking DRAM widths include x1, x4, x8. For Example:

| Module width | Primary DRAM Width | Error Checking DRAM Width | Qty of Error Checking DRAMs | Byte 14 (Binary) |
|---|---|---|---|---|
| x72 | x9 | — | — | 0000 0000 |
| x72 | x8 | x8 | 1 | 0000 1000 |
| x72 | x16 | x1 | 8 | 0000 0001 |

| DRAM Width Error Checking DRAM | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 255 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

4.12 **Bytes 15–31:** Open. There are no defined PD settings for these bytes.

4.13 **Bytes 32 through 62, Superset information:** If a superset technology is developed and is completely backward compatible, it may be specified and its SPD may be defined in bytes 32 through 62.

4.14 **Byte 63, Checksum for bytes 0–62:** At time of the publish of this standard, the checksum method is currently in ballot and is not yet incorporated, suggested method is modulo 256.

5 **From the general SPD standard:** The descriptions of bytes 64–127 are repeated here For Reference ONLY. Manufacturers MAY include information which is pertinent to their particular modules, place and date of manufacture, etc. If a module manufacturer decides to write data into bytes 64–127, they must follow the format and order presented below. If a module manufacturer chooses not to include the data outlined below, they must leave bytes 64–127 unprogrammed; blank state of these bytes may be 00h or FFh. Detailed implementation of bytes 64–127 is detailed below in paragraphs 5.X:

5.1 **Bytes 64–71:** Manufacturers ID code per EIA/JEP106. Manufacturers of a given module may include their identifier per Jedec spec JEP106. 00h is not allowed and FFh indicated continuation. The first byte is utilized, the second byte filling. Unused locations/bytes should be FFh.

5.2 **Byte 72:** Manufacturing Location. Manufacturers may include an identifier which uniquely defines the manufacturing location of the memory module. While the SPD spec will not attempt to present a decode table for manufacturing sites, the individual manufacturer may keep track of manufacturing location and its appropriate decode represented in this byte.

5.3 **Bytes 73–90:** Manufacturer's Part Number: Manufacturers may include their part number in 6–bit ASCII format within these bytes.

5.4: **Bytes 91–92:** Revision Code: This refers to the module revision code. While the SPD spec will not attempt to define the format for this information, the individual manufacturer may keep track of the revision code and its appropriate decode represented in this byte.

5.5 **Bytes 93–94:** Date of Module Manufacture: The module manufacturer may include a date code for the module. Specifically, byte 93 may contain the year in Binary and byte 94 may contain the week in Binary.

5.6 **Bytes 95–98:** Module Serial Number: The supplier may include a serial number for module. The supplier may use whatever decode method desired to maintain a unique serial number for each module.

5.7 **Bytes 99–125:** Manufacturers specific data, open area. The module manufacturer may add any additional information desired into the module within these locations.

5.8 **Bytes 126–127:** Reserved. These bytes are reserved and cannot be later allocated.

## 4.1.2.4 – Appendix D: Table not yet defined

Table D is not yet defined. It will be placed in this location when it is published.

# 4.1.2.5 – Appendix E: Specific PD's for Synchronous DRAM (SDRAM).

Date of last update: 11/25/96

1. **Introduction:** This appendix describes the Presence Detects for Synchronous DRAM Modules. These PD's are those referenced in the SPD standard document for "Specific Features". The following PD fields will occur, in the order presented, in table 1.1. Further descriptions of bytes 0 and 1 are found in the SPD standard. Further description of byte 2 is found in appendix A of the SPD standard.

1.1 **Address map:** The following is the SPD address map for SDRAM. It describes where the individual LUT–Entries/bytes will be held in the serial EEPROM:

| Byte Number | Function described | Notes |
|---|---|---|
| 0 | Defines # bytes written into serial memory at module mfgr | 1 |
| 1 | Total # bytes of SPD memory device | 2 |
| 2 | Fundamental memory type (FPM, EDO, SDRAM...) from appendix A | |
| 3 | # Row Addresses on this assembly | 3 |
| 4 | # Column Addresses on this assembly | |
| 5 | # Module Banks on this Assembly | |
| 6 | Data Width of this assembly... | |
| 7 | ...Data Width continuation | |
| 8 | Voltage interface standard of this assembly | |
| 9 | SDRAM Cycle time at Max. Supported CAS Latency (CL), CL=X | 4 |
| 10 | SDRAM Access from Clock | 4 |
| 11 | DIMM Configuration type (Non–parity, Parity, ECC) | |
| 12 | Refresh Rate/Type | 4,5 |
| 13 | SDRAM width, Primary DRAM | |
| 14 | Error Checking SDRAM data width | |
| 15 | Minimum Clock Delay, Back to Back Random Column Addresses | |
| 16 | Burst Lengths Supported | |
| 17 | # Banks on Each SDRAM device | 4 |
| 18 | CAS# Latencies Supported | 4 |
| 19 | CS# Latency | 4 |
| 20 | Write Latency | 4 |
| 21 | SDRAM Module Attributes | |
| 22 | SDRAM Device Attributes: General | |
| 23–31 | TBD | |
| 32–62 | Superset information | |
| 63 | Checksum for bytes 0–62 | |
| 64–71 | Manufacturers JEDEC ID code per JEP–106E | 6 |
| 72 | Manufacturing location | 6 |
| 73–90 | Manufacturer's Part Number | 6 |
| 91–92 | Revision Code | 6 |
| 93–94 | Manufacturing date | 6 |
| 95–98 | Assembly Serial Number | 6 |
| 99–125 | Manufacturer Specific Data | |
| 126–127 | Reserved | |
| 128–255 | Open for Customer use. | 7 |

notes:

1) This will be programmed as 128 bytes for the 168 pin DIMM Module.
2) This must be programmed as 256 bytes, 256 byte EEPROM's will be used for SPD on 168 pin SDRAM DIMMs.
3) High order bit defines if assembly has "redundant" addressing (if set to "1", highest order RAS# address must be re–sent as highest order CAS# address.)
4) From data sheet.
5) High order bit (MSB) is Self Refresh $flag'. If bit seven is "1", assembly supports self refresh.
6) The JEDEC spec specifies that these bytes are optional.
7) Module suppliers will need to assure that these bytes are open for reads/writes by Customer.

**Release 7**

2 **For Reference, Bytes 1–3:** Descriptions of bytes 1 and 2 can be found in the main body of the SPD standard, and byte 3 is detailed in appendix A to this standard. For reference and convenience, applicable portions of their descriptions are presented again:

2.1 **BYTE 0:** From General SPD Standard, Number of Bytes used by Module Manufacturer: This field describes the total number of bytes used by the module manufacturer for the SPD data and any (optional) specific supplier information. The byte count includes the fields for all required and optional data.

| Number SPD Bytes | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 10 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 11 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 128 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 254 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 255 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

2.2 **Byte 1:** From General SPD Standard, Total SPD Memory Size: This field describes the total size of the serial memory used to hold the Serial Presence Detect data. The following lookup table describes the possible serial memory densities (in bytes) along with the corresponding descriptor:

| Serial Memory Density | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| RFU | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 Bytes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 4 Bytes | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 8 Bytes | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 16 Bytes | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 32 Bytes | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 64 Bytes | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 128 Bytes | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 256 Bytes | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 512 Bytes | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 1024 Bytes | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 2048 Bytes | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 4096 Bytes | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 8192 Bytes | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 16284 Bytes | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| . | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| . | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

2.3 Byte 2, From Appendix A, Memory Type: This byte describes the fundamental memory type (or technology) implemented on the module:

| Fundamental Mem. Type | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| SDRAM | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |

**3. Data Type(s):** Even though many of the PD's seem to be binary numbers representing the feature they are describing, they are considered Look Up Table (LUT) entries.

**4.** The following PD bytes are those specific to modules implementing Synchronous DRAM technology. Note that these full descriptions start at byte 3 below and are not covered in the main body of the SPD standard since they are specific to a given fundamental memory type/technology

**4.1 Byte 3: Number of ROW Addresses:** This first field describes the number of row Addresses in the SDRAM array. This does not include the Bank Select pin. For example, the number of Row Addresses used on a 2MX64 SDRAM DIMM is

Decimal 11 Binary 0000 1011 Addresses (for RA0 through RA10):

| No. of Row Addr | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 10 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 11 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 12 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 14 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| . | . | . | . | . | . | . | . | . |
| 127 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Undefined | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| 12(redundant) | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 13(redundant) | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 14(redundant) | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| . | . | . | . | . | . | . | . | . |
| 126(redundant) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 127(redundant) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

Bit7: "0" indicates normal addressing; "1" indicates redundant addressing

4.2 **Byte 4: Number of COLUMN Addresses:** This field describes the number of COLUMN Addresses in the module's SDRAM array:

| Number of Columns | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 10 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 11 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 12 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 14 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| | . | . | . | . | . | . | . | . |
| | . | . | . | . | . | . | . | . |
| 254 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 255 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

4.3 **Byte 5: Number of Banks on module:** This field describes the number of physical banks on the SDRAM Module. This is not to be confused with the number of logical banks on a given SDRAM device :

| Number of Banks | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 10 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 11 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 12 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 14 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| | . | . | . | . | . | . | . | . |
| | . | . | . | . | . | . | . | . |
| 254 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 255 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |



XILINX EXHIBIT 1012
Page 194

**4.4 Bytes 6 & 7, Module Data Width:** Bytes 6 and 7 are used to designate the modules data width. The data width is presented as a 16 bit word; bit 0 of byte 6 becomes the LSB of the 16 bit width identifier and bit7 of byte 7 becomes the MSB. Consequently, if the module has a width of less than 255 bits wide, byte 7 will be 00h. If the data width is 256 bits or higher, byte 7 is used in conjunction with byte 6 to designate the total module width. For example, if the module's

| data width is: | then byte 7 is | and byte 6 is: |
|---|---|---|
| 64 | 0000 0000 | 0100 0000 |
| 72 | 0000 0000 | 0100 1000 |
| 80 | 0000 0000 | 0101 0000 |
| 576 | 0000 0010 | 0100 0000 |

**4.4.1 Byte 6:**

| Data Width | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 32 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| 36 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 64 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| 72 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 80 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 128 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| 144 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 254 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 255 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**4.4.2 Byte 7. Module Data Width Continued:** This byte will be left at 00h if the original module data width is less than 256 bits wide. If the width is more than 255, then this byte will be used in conjunction with byte 6.

| Module Data Width Cont. | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| 0(+) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 256(+) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 512(+) | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 1024(+) | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 2048(+) | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |

**4.5 Byte 8, Module Interface Levels:** This field describes the module's voltage interface:

| Voltage Interface | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| 5.0 Volt/TTL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LVTTL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| HSTL 1.5 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| SSTL 3.3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| SSTL 2.5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| TBD | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| TBD | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| . | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |



XILINX EXHIBIT 1012
Page 195

4.6 **Byte 9, SDRAM Cycle time (tCYC):** This byte defines the minimum cycle time for the SDRAM Module at the highest CAS Latency, CAS Latency=X, defined in byte 18. If other CAS latencies are supported, then the associated minimum cycle times are not related in this version of the SPD standard. At this time of publication, proposals are being made to widen the standard to relate cycletimes at lower CAS Latencies. Byte 9, Cycle time for CAS Latency = X, is split into two nibbles: the higher order nibble (bits 4 through 7) designate the cycle time to a granularity of 1ns; the value presented by the lower order nibble (bits 0 through 3) has a granularity of 1/10ns and is added to the value designated by the higher nibble. For example, if

| Bits 7:4 are | and bits 3:0 are | then the cycle time is |
|---|---|---|
| 1010 | 0101 | |
| (10ns) + | (0.5ns) | = 10.5ns |

| Nanoseconds | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| SDRAM Cycle Time Subfield A: | | | | | | | | |
| Units of nanoseconds (bits 4 through 7) | | | | | SEE Subfield Table B | | | |
| Undefined | 0 | 0 | 0 | 0 | | | | |
| 1ns/16ns | 0 | 0 | 0 | 1 | | | | |
| 2ns | 0 | 0 | 1 | 0 | | | | |
| 3ns | 0 | 0 | 1 | 1 | | | | |
| 4ns | 0 | 1 | 0 | 0 | | | | |
| 5ns | 0 | 1 | 0 | 1 | | | | |
| 6ns | 0 | 1 | 1 | 0 | | | | |
| 7ns | 0 | 1 | 1 | 1 | | | | |
| 8ns | 1 | 0 | 0 | 0 | | | | |
| 9ns | 1 | 0 | 0 | 1 | | | | |
| 10ns | 1 | 0 | 1 | 0 | | | | |
| 11ns | 1 | 0 | 1 | 1 | | | | |
| 12ns | 1 | 1 | 0 | 0 | | | | |
| 13ns | 1 | 1 | 0 | 1 | | | | |
| 14ns | 1 | 1 | 1 | 0 | | | | |
| 15ns | 1 | 1 | 1 | 1 | | | | |
| SDRAM Cycle Time Subfield B: | | | | | | | | |
| Tenths of ns (bits 0 through 3) | SEE Subfield table A | | | | | | | |
| +0ns | | | | | 0 | 0 | 0 | 0 |
| +0.1ns | | | | | 0 | 0 | 0 | 1 |
| +0.2ns | | | | | 0 | 0 | 1 | 0 |
| +0.3ns | | | | | 0 | 0 | 1 | 1 |
| +0.4ns | | | | | 0 | 1 | 0 | 0 |
| +0.5ns 1 | | | | | | 0 | 1 | 0 |
| +0.6ns | | | | | 0 | 1 | 1 | 0 |
| +0.7ns | | | | | 0 | 1 | 1 | 1 |
| +0.8ns | | | | | 1 | 0 | 0 | 0 |
| +0.9ns | | | | | 1 | 0 | 0 | 1 |
| RFU | | | | | 1 | 0 | 1 | 0 |
| . | . | . | . | . | . | . | . | . |
| Undefined | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |



XILINX EXHIBIT 1012
Page 196

**4.7 Byte 10, SDRAM Access time from Clock (tAC):** This byte defines the maximum clock to data out for the module. This is the Clock to data out specification at the highest given CAS Latency specified/depicted in byte 18 of this SPD specification/ standard. If other CAS latencies are supported, then the associated Maximum Clock Access times are not related in this version of the SPD standard. At this time of publication, proposals are being made to widen the standard to relate tAC's at lower CAS Latencies. The byte is split into two nibbles: the higher order nibble (bits 4 through 7) designate the cycle time to a granularity of 1ns; the value presented by the lower order nibble (bits 0 through 3) has a granularity of 1/10ns and is added to the value designated by the higher nibble. For example, if

Bits 7:4 are 1001 (9ns) + and bits 3:0 are 0000 (0.0ns) = then the cycle time is 9.0ns

| Nanoseconds | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| SDRAM Access time from Clock: | | | | | | | | |
| Subfield A: Units of nanoseconds (bits 4 through 7) | | | | | | | | |
| Undefined | 0 | 0 | 0 | 0 | SEE Subfield Table B | | | |
| 1ns | 0 | 0 | 0 | 1 | | | | |
| 2ns | 0 | 0 | 1 | 0 | | | | |
| 3ns | 0 | 0 | 1 | 1 | | | | |
| 4ns | 0 | 1 | 0 | 0 | | | | |
| 5ns | 0 | 1 | 0 | 1 | | | | |
| 6ns | 0 | 1 | 1 | 0 | | | | |
| 7ns | 0 | 1 | 1 | 1 | | | | |
| 8ns | 1 | 0 | 0 | 0 | | | | |
| 9ns | 1 | 0 | 0 | 1 | | | | |
| 10ns | 1 | 0 | 1 | 0 | | | | |
| 11ns | 1 | 0 | 1 | 1 | | | | |
| 12ns | 1 | 1 | 0 | 0 | | | | |
| 13ns | 1 | 1 | 0 | 1 | | | | |
| 14ns | 1 | 1 | 1 | 0 | | | | |
| 15ns | 1 | 1 | 1 | 1 | | | | |
| SDRAM Access time from CLK | | | | | | | | |
| Subfield B: Tenths of ns (bits 0 through 3) | | | | | | | | |
| +0ns | SEE Subfield Table A | | | | 0 | 0 | 0 | 0 |
| +0.1ns | | | | | 0 | 0 | 0 | 1 |
| +0.2ns | | | | | 0 | 0 | 1 | 0 |
| +0.3ns | | | | | 0 | 0 | 1 | 1 |
| +0.4ns | | | | | 0 | 1 | 0 | 0 |
| +0.5ns | | | | | 0 | 1 | 0 | 1 |
| +0.6ns | | | | | 0 | 1 | 1 | 0 |
| +0.7ns | | | | | 0 | 1 | 1 | 1 |
| +0.8ns | | | | | 1 | 0 | 0 | 0 |
| +0.9ns | | | | | 1 | 0 | 0 | 1 |
| RFU | | | | | 1 | 0 | 1 | 0 |
| . | | | | | . | . | . | . |
| Undefined | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**4.8 Byte 11, Module Configuration type:** This field describes the module's error detection and or correction schemes:

| Error Det/Cor | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| None | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Parity | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| ECC | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| TBD | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| TBD | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| TBD | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| TBD | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| TBD | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |



XILINX EXHIBIT 1012
Page 197

4.9 **Byte 12, Refresh Rate/Type:** This field describes the module's refresh rate and type:

| Refresh Period Bit 0 | Bit 7, Self Refresh Flag | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Normal (15.625 us) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced (.25x)...3.9us | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Reduced (.5x)...7.8us | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Extended (2x)...31.3us | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Extended (4x)...62.5us | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Extended (8x)...125us | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| TBD | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| TBD | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| TBD | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| TBD | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| Self Refresh Entries | | | | | | | | |
| Normal (15.625us) | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced (0.25x)...3.9us | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Reduced (0.5x)...7.8us | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Extended (2x)...31.3us | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Extended (4x)...62.5us | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Extended (8x)...125us | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| TBD | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| TBD | . | . | . | . | . | . | . | . |
| TBD | . | . | . | . | . | . | . | . |
| TBD | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| TBD | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

4.10 **Byte 13, SDRAM width, Primary SDRAM:** This field describes the width of the primary SDRAMs used on the module. The primary SDRAM is that which is used for data; examples of primary (data) SDRAM widths are x4, x8, x16, x32. Note that if the module is made with SDRAMs which provide for data and error checking e.g. x9, x18, x36, then it is also designated in this field. Examples using (1 bank) x72 modules include:

| Module width | Primary Data SDRAM Width | Error Checking SDRAM Width | Qty Primary Data SDRAMs | Byte 13 (Binary) |
|---|---|---|---|---|
| x72 | x9 | — | 8 | 0000 1001 |
| x72 | x8 | x8 | 9 | 0000 1000 |
| x72 | x16 | x4 | 4 | 0001 0000 |

| SDRAM Width, Primary SDRAM Bit 0 | | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 15 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 16 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| 18 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| . | . | . | . | . | . | . | . | . |
| 32 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| 36 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 255 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**4.11 Byte 14, Error Checking SDRAM data width:** If the module incorporates error checking and if the primary data SDRAM does not include these bits; i.e. there are separate error checking SDRAMs, then the error checking SDRAM's width is expressed in this byte. Examples of error checking SDRAM widths include x4, x8, x16. For Example:

| Module width | Primary SDRAM Width | Error Checking SDRAM Width | Qty of Error Checking SDRAMs | Byte 14 (Binary) |
|---|---|---|---|---|
| x72 | x9 | — | — | 0000 0000 |
| x72 | x8 | x8 | 1 | 0000 1000 |
| x72 | x16 | x4 | 8 | 0000 0100 |

| SDRAM Width Error Checking DRAM | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 255 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**4.12 Byte 15, as determined by the limiting part on the assembly, SDRAM Device Attributes:** Minimum Clock Delay, Back to Back Random Column Accesses. Note that SDRAM architecture can be gained with this parameter. A latency of 1 for random writes denotes Pipelined SDRAM and a latency of 2 for random writes denotes Prefetch SDRAMs:

| Number of Clocks | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| . | . | | | | | . | | |
| . | . | | | | | . | | |
| 255 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**4.13 Byte 16, SDRAM Device Attributes, Burst Lengths Supported:** This byte describes which various programmable burst lengths are supported by the devices on the module. If the bit is "1", then that Burst Length is supported on the module; If the bit is "0", then that burst length is not supported by the module.

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Burst Length = Page | TBD | TBD | TBD | Burst Length = 8 | Burst Length = 4 | Burst Length = 2 | Burst Length = 1 |
| 1 or 0 | 0 | 0 | 0 | 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 |

**4.14 Byte 17, SDRAM Device Attributes, Number of Banks on the discrete SDRAM Device:** This byte details how many banks are on each discrete SDRAM installed onto the module:

| Number of Banks | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| . | . | | | | | . | | |
| . | . | | | | | . | | |
| 255 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

4.15 **Byte 18, SDRAM Device Attributes, CAS# Latency:** This byte describes which of the programmable CAS# Latencies are supported by the Module. If the bit is "1", then that CAS# Latency is supported on the module; If the bit is "0", then that CAS# Latency is not supported by the module. Bytes 9,10,23–26 all relate CAS Latency dependent timings.

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| TBD | CAS# Latency = 7 | CAS# Latency = 6 | CAS# Latency = 5 | CAS# Latency = 4 | CAS# Latency = 3 | CAS# Latency = 2 | CAS# Latency = 1 |
| 0 | 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 |

4.16 **Byte 19, SDRAM Device Attributes, CS# Latency:** This byte describes which of the programmable CS# Latencies are acceptable for the Module. If the bit is "1", then that CS# Latency is supported on the module; If the bit is "0", then that CS# Latency is not supported by the module.

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| TBD | CS# Latency = 6 | CS# Latency = 5 | CS# Latency = 4 | CS# Latency = 3 | CS# Latency = 2 | CS# Latency = 1 | CS# Latency = 0 |
| 0 | 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 |

4.17 **Byte 20, SDRAM Device Attributes, WE# Latency:** This byte describes which of the programmable WE# Latencies are acceptable for the Module. If the bit is "1", then that WE# Latency is supported on the module; If the bit is "0", then that WE# Latency is not supported by the module.

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| TBD | WE# Latency = 6 | WE# Latency = 5 | WE# Latency = 4 | WE# Latency = 3 | WE# Latency = 2 | WE# Latency = 1 | WE# Latency = 0 |
| 0 | 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 |

4.18 **Byte 21, SDRAM Module Attributes:** This byte depicts various aspects of the module. It details various unrelated but critical elements pertinent to the module. A given module characteristic is detailed in the designated bit; if the aspect is TRUE, then the bit is "1". Conversely, if the aspect is FALSE, then the designated bit is "0".

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| TBD | TBD | Differential Clock Input | Registered DQMB Inputs | Buffered DQMB Inputs | On–Card PLL (Clock) | *Registered Address/Control Inputs | *Buffered Address/Control Inputs |
| 0 | 0 | 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 |

* Address, RAS, CAS, WE, CKE, CS

4.19 **Byte 22, SDRAM Device Attributes, General:** This byte depicts various aspects of the SDRAMs on the module. It details various unrelated but critical elements pertinent to the SDRAMs. A given SDRAM characteristic is detailed in the designated bit; if the aspect is TRUE, then the bit is "1". Conversely, if the aspect is FALSE, then the designated bit is "0".

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| TBD | TBD | TBD | TBD | Supports Write1/Read Burst | Supports Precharge All | Supports Auto–Precharge | Supports Early RAS# Precharge |
| 0 | 0 | 0 | 0 | 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 |

# 4.1.2.6 – Appendix F: Specific PD's for Address Multiplexed ROMs (MXROM).

**1.0 Introduction:** This appendix describes the Presence Detects for Multiplexed ROM modules. These PD's are those referenced in the SPD standard as "Specific Features". The following PD fields will occur, in the order presented, at the point in the standard where the Specific Features are referenced; that is after the identification of the Fundamental Memory Type and before identification of whether there is any Superset Features presented. For convenience sake however, the complete address map is presented herein.

**1.1 Address map:** The following is the SPD address map for Multiplexed ROM. It describes where the individual LUT–Entries/ bytes will be held in the serial EEPROM:

| Byte Number | Function described | Notes |
|---|---|---|
| 0 | Defines # bytes written into serial memory at module mfgr | 1 |
| 1 | Total # bytes of SPD memory device | 2 |
| 2 | Fundamental memory type (FPM, EDO, SDRAM...) from appendix A | |
| 3 | # Row Addresses on this assembly | |
| 4 | # Column Addresses on this assembly | |
| 5 | # ROM Banks on this Assembly | |
| 6 | Data Width of this assembly... | |
| 7 | ...Data Width continuation | |
| 8 | Voltage interface standard of this assembly | |
| 9 | Address Access Time of this assembly$ | 3 |
| 10 | $Address Access Time continuation | 3 |
| 11 | DIMM Configuration type (Non–parity, Parity, ECC) | |
| 12 | Reserved | |
| 13 | Page Mode Access Time of this assembly | 3 |
| 14 | Output Enable Access Time of this assembly | 3 |
| 15 | Chip Enable Access Time of this assembly$ | 3 |
| 16 | $Chip Enable Access Time continuation | 3 |
| 17 | Burst Length of this assembly | |
| 18–31 | Reserved for future offerings | |
| 32 | Superset Memory Type (may be used in future) | |
| 33–62 | Superset Memory Specific Features (may be used in future) | |
| 63 | Checksum for bytes 0–62 | |
| 64–71 | Manufacturers JEDEC ID code per JEP–106 | 4 |
| 72 | Manufacturing location | 4 |
| 73–90 | Manufacturer's Part Number | 4 |
| 91–92 | Revision Code | 4 |
| 93–94 | Manufacturing date | 4 |
| 95–98 | Assembly Serial Number | 4 |
| 99–125 | Manufacturer Specific Data | 4 |
| 126–127 | Reserved | |
| 128–255 | Open User Free–Form area$not defined | |

notes:

1) This will be 128 bytes for Multiplexed ROM assemblies.
2) This will be 256 bytes, represented as 08h. See below.
3) From data sheet.
4) Per the JEDEC spec, these are optional.

2 **Bytes #0–2, For Reference:** Descriptions of bytes 0–1 can be found in the main body of the SPD standard, and byte 2 is detailed in appendix A to this standard. For reference and convenience, applicable portions of their descriptions are presented again:

2.1 **BYTE #0, From General SPD Standard, Number of Bytes used by Module Manufacturer:** This field describes the total number of bytes used by the module manufacturer for the SPD data and any (optional) specific supplier information. The byte count includes the fields for all required and optional data.

| Number SPD Bytes | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 10 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 11 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 128 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 254 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 255 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

2.2 **Byte #1, From General SPD Standard, Total SPD Memory Size:** This field describes the total size of the serial memory used to hold the Serial Presence Detect data. The following lookup table describes the possible serial memory densities (in bytes) along with the corresponding descriptor:

| Serial Memory Density | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| RFU | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 Bytes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 4 Bytes | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 8 Bytes | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 16 Bytes | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 32 Bytes | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 64 Bytes | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 128 Bytes | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 256 Bytes | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 512 Bytes | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 1024 Bytes | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 2048 Bytes | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 4096 Bytes | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 8192 Bytes | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 16284 Bytes | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| . | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| . | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |



XILINX EXHIBIT 1012
Page 202

2.3 **Byte #2, From Appendix A, Memory Type:** This byte describes the fundamental memory type (or technology) implemented on the module:

| Fundamental Mem. Type | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Reserved | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Standard FPM DRAM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| EDO | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| . | . | . | . | . | . | . | . | . |
| Multiplexed ROM | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

3 **Data Type(s):** Even though many of the PD's seem to be binary numbers representing the feature they are describing, they are considered Look Up Table (LUT) entries.

4 The following PD bytes are those specific to modules implementing ROM devices with a multiplexed address interface. Note that full descriptions start at byte 3 and are not covered in the main body of the SPD standard since they are specific to a given fundamental memory type/technology.

4.1 **Byte #3, Number of ROW Addresses:** This first field describes the number of Row Addresses in the ROM array:

| No. of Row Addresses | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 10 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 11 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 12 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 14 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 254 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 255 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

4.2 **Byte #4, Number of COLUMN Addresses:** This field describes the number of COLUMN addresses in the module's ROM array:

| Number of COLUMN Addresses | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 10 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 11 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 12 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 14 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| | . | . | . | . | . | . | . | . |
| | . | . | . | . | . | . | . | . |
| 254 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 255 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

4.3 **Byte #5, Number of Banks:** This field describes the number of banks on the ROM Module.

| Number of Banks | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 10 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 11 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 12 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 14 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| | . | . | . | . | . | . | . | . |
| | . | . | . | . | . | . | . | . |
| 254 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 255 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |



XILINX EXHIBIT 1012
Page 204

**4.4 Bytes 6 & 7, Module Data Width:** Bytes 6 and 7 are used to designate the modules data width. The data width is presented as a 16 bit word; bit 0 of byte 6 becomes the LSB of the 16 bit width identifier and bit7 of byte 7 becomes the MSB. Consequently, if the module has a width of less than 255 bits wide, byte 7 will be 00h. If the data width is 256 bits or higher, byte 7 is used in conjunction with byte 6 to designate the total module width. For example, if the module's

| data width is: | then byte 7 is | and byte 6 is: |
|---|---|---|
| 64 | 0000 0000 | 0100 0000 |
| 72 | 0000 0000 | 0100 1000 |
| 80 | 0000 0000 | 0101 0000 |
| 576 | 0000 0010 | 0100 0000 |

**4.4.1 Byte 6:**

| Data Width | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Undefined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 32 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| 36 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 64 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| 72 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 128 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| 144 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| 254 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 255 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**4.4.2 Byte #7, Module Data Width Continued:** This byte will be left at 00h if the original module data width is less than 256 bits wide. If the width is more than 255, then this byte will be used in conjunction with byte 6.

| Module Data Width Cont. | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| 0(+) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 256(+) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 512(+) | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 1024(+) | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 2048(+) | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |

**4.5 Byte #8, Module Interface Levels:** This field describes the module's voltage interface:

| Voltage Interface | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| 5.0 Volt/TTL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LVTTL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| HSTL 1.5 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| SSTL 3.3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| SSTL 2.5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| TBD | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| TBD | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| New Table | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

4.6 **Bytes #9 & #10, Address Access Time ($t_{AA}$):** Bytes 9 and 10 are used to designate the address access time of the module. This access time is presented as a 16 bit word; bit 0 of byte 9 becomes the LSB of the 16 bit access time identifier and bit 7 of byte 10 becomes the MSB. Consequently, if the module has an address access time of less than 256ns, byte 10 will have a value of 00h. If the address access time is 256ns or greater, byte 10 is used in conjunction with byte 9 to designate the total access time.

4.6.1 **Byte 9:**

| Address Access Time (LSB) | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Reserved | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 (+x0A) ns | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 (+x0A) ns | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| – | – | – | – | – | – | – | – | – |
| – | – | – | – | – | – | – | – | – |
| 254 (+x0A) ns | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| 255 (+x0A) ns | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| New Table | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

4.6.2 **Byte #10, Address Access Time Continued:** This byte will be left at 00h if the address access time of the module is less than 256 nanoseconds. If the address access time of the module is 256 nanoseconds or greater, byte 10 is used in conjunction with byte 9 to determine the access time of the assembly.

| Address Access Time (MSB) | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| 0 (+x09) ns | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 256 (+x09) ns | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 512 (+x09) ns | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 1024 (+x09) ns | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 2048 (+x09) ns | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 4096 (+x09) ns | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 8192 (+x09) ns | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 16384 (+x09) ns | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| – | – | – | – | – | – | – | – | – |

4.7 **Byte #11, Module Configuration type:** This field describes the module's error detection and or correction schemes:

| Error Det/Cor | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| None | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Parity | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| ECC | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| TBD | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| TBD | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| TBD | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| TBD | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . |
| TBD | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

4.8 **Byte #12, Reserved:** This byte is reserved for future offerings.



XILINX EXHIBIT 1012
Page 206

**4.9 Byte #13, Page Mode Access Time ($t_{PA}$):** Byte 13 represents the page mode access time from chip enable of the device ($t_{PA}$) in nanoseconds.

| Page Mode Access Time | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Reserved | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 ns | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 ns | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| – | – | – | – | – | – | – | – | – |
| – | – | – | – | – | – | – | – | – |
| 253 ns | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| 254 ns | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| New Table | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**4.10 Byte #14, Output Enable Access Time ($t_{OE}$):** Byte x14 represents the access time from output enable of the device ($t_{OE}$) in nanoseconds.

| Output Enable Access Time | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Reserved | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 ns | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 ns | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| – | – | – | – | – | – | – | – | – |
| – | – | – | – | – | – | – | – | – |
| 253 ns | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| 254 ns | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| New Table | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**4.11 Bytes #15 & #16, Chip Enable Access Time ($t_{OE}$):** Bytes 15 and 16 are used to designate the access time from chip enable of the module. This access time is presented as a 16 bit word; bit 0 of byte 15 becomes the LSB of the 16 bit access time identifier and bit 7 of byte 16 becomes the MSB. Consequently, if the module has a chip enable access time of less than 256ns, byte 16 will have a value of 00h. If the chip enable access time is 256ns or greater, byte 16 is used in conjunction with byte 15 to designate the total chip enable access time.

**4.11.1 Byte #15:**

| Chip Enable Access Time (LSB) | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| Reserved | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 (+x0F) ns | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 (+x0F) ns | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| – | – | – | – | – | – | – | – | – |
| – | – | – | – | – | – | – | – | – |
| 254 (+x0F) ns | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| 255 (+x0F) ns | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**4.11.2 Byte #16, Chip Enable Access Time Continued:** This byte will be left at 00h if the chip enable access time of the module is less than 256 nanoseconds. If the chip enable access time of the module is 256 nanoseconds or greater, byte 16 is used in conjunction with byte 15 to determine the chip enable access time of the assembly.

| Chip Enable Access Time (MSB) | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| 0 (+x0F) ns | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 256 (+x0F) ns | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 512 (+x0F) ns | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 1024 (+x0F) ns | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 2048 (+x0F) ns | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 4096 (+x0F) ns | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 8192 (+x0F) ns | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 16384 (+x0F) ns | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| – | – | – | – | – | – | – | – | – |

4.12 **Byte #17, Burst Length:** Byte 17 is an 8 bit mask which indicates all burst lengths supported by the device. If a bit in byte 17 is "1" then the associated burst length is supported by the module. If the bit is "0", then that burst length is not supported.

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Burst Length = Page | TBD | TBD | TBD | Burst Length 8 | Burst Length 4 | Burst Length 2 | Burst Length 1 |
| 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 | 1 or 0 |

4.13 **Bytes 18–31:** Open. There are no defined PD settings for these bytes.

4.14 **Bytes 32 through 62, Superset information:** If a superset technology is developed and is completely backward compatible, it may be specified and its SPD may be defined in bytes 32 through 62.

4.15 **Byte 63, Checksum for bytes 0–62:** At time of the publish of this standard, the checksum method is currently in ballot and is not yet incorporated, suggested method is modulo 256.

5 **From the general SPD standard:** The descriptions of bytes 64–127 are repeated here For Reference ONLY. Manufacturers MAY include information which is pertinent to their particular modules, place and date of manufacture, etc. If a module manufacturer decides to write data into bytes 64–127, they must follow the format and order presented below. If a module manufacturer chooses not to include the data outlined below, they must leave bytes 64–127 unprogrammed; blank state of these bytes may be 00h or FFh. Detailed implementation of bytes 64–127 is detailed below in paragraphs 5.X:

5.1 **Bytes 64–71, Manufacturers ID code per EIA/JEP106.** Manufacturers of a given module may include their identifier per Jedec spec JEP106. 00h is not allowed and FFh indicated continuation. The first byte is utilized, the second byte filling. Unused locations/bytes should be FFh.

5.2 **Byte 72, Manufacturing Location.** Manufacturers may include an identifier which uniquely defines the manufacturing location of the memory module. While the SPD spec will not attempt to present a decode table for manufacturing sites, the individual manufacturer may keep track of manufacturing location and its appropriate decode represented in this byte.

5.3 **Bytes 73–90, Manufacturer's Part Number:** Manufacturers may include their part number in 6–bit ASCII format within these bytes.

5.4 **Bytes 91–92, Revision Code:** This refers to the module revision code. While the SPD spec will not attempt to define the format for this information, the individual manufacturer may keep track of the revision code and its appropriate decode represented in this byte.

5.5 **Bytes 93–94, Date of Module Manufacture:** The module manufacturer may include a date code for the module. Specifically, byte 93 may contain the year in Binary and byte 94 may contain the week in Binary.

5.6 **Bytes 95–98, Module Serial Number:** The supplier may include a serial number for module. The supplier may use whatever decode method desired to maintain a unique serial number for each module.

5.7 **Bytes 99–125, Manufacturers specific data, open area:** The module manufacturer may add any additional information desired into the module within these locations.

5.8 **Bytes 126–127, Reserved:** These bytes are reserved and cannot be later allocated.



XILINX EXHIBIT 1012
Page 208

## 4.2 One Byte Memory Modules

### 4.2.1 – 22 PIN SIP/SIMM DRAM MODULE

CAPACITY—64K, 256K WORDS OF 4 BITS
CONFIGURATION—SINGLE SIDED MODULE USING 64K OR 256K DEVICES
PACKAGE—22 PIN SIP MODULE
PIN ASSIGNMENTS—Fig. 4.2–1

### – 24 PIN SIP/SIMM DRAM MODULE

CAPACITY—128K, 512K WORDS OF 4 BITS
CONFIGURATION—DOUBLE SIDED MODULE USING 64K OR 256K DEVICES
PACKAGE—24 PIN SIP MODULE
PIN ASSIGNMENTS—Fig. 4.2–1

### – 30 PIN SIP/SIMM DRAM MODULE

CAPACITY—64K, 256K, 1M, 4M WORDS OF 8 OR 9 BITS, & 16M WORDS OF 8 BITS
CONFIGURATION—SINGLE SIDED MODULE
—USING 64K, 256K, 1M, 4M, OR 16M MEMORY DEVICES
LOGIC FEATURES—Some of the modules contain a "presence detect" feature which conists of outputs that supply an encoded value which defines the storage capacity of the module.
PACKAGE—30 PIN SIP MODULE
PIN ASSIGNMENTS—Fig. 4.2–1

### 4.2.2 – 30 PIN SIP/SIMM DRAM MODULE FAMILY

CAPACITY —64K TO 8M WORDS OF 4 OR 5 BITS
—128K TO 16M WORDS OF 2 BITS
—256K TO 32M WORDS OF 1 BIT
CONFIGURATION—ONE OR TWO SIDED,
—USING 64K, 256K, 1M, OR 4M DEVICES
CAPACITY—32K, 64K, 128K, 256K WORDS OF 8 BITS
PACKAGE—30 PIN SIP MODULE
PIN ASSIGNMENT Fig. 4.2–2

### 4.2.3 – 23/25/26/28 PIN ZIP/SIMM DRAM MODULE FAMILY

CAPACITY —256K TO 16M WORDS OF 4 BIT
—1M TO 64M WORDS OF 1 BIT
CONFIGURATION—DOUBLE SIDED, USING 1M, 4M, 16M, OR 64M DEVICES
PACKAGE—THE X4 MODULES, 26 PIN ZIP/SIP MODULE
THE X1 MODULES, 23 PIN ZIP/SIP MODULE
PIN ASSIGNMENTS—Fig. 4.2–3
NOTE: At the highest density using 64M memory devices, the modules must be expanded to 25 or 28 pins to provide the needed addresses. These modules will be defined in more detail when the packages for the 64M memory devices have been defined.

### 4.2.4 – 60 PIN ZIP/SIMM SRAM MODULE

CAPACITY—2 X 64K, 2 X 256K, 2 X 1M WORDS OF 4 BITS
CONFIGURATION—DUAL BANK MODULE USING DEVICES WITH 64K, 256K, OR 1M WORDS—SELECTABLE AS 64K, 256K, OR 1M BY 8, 128K, 512K, OR 2M BY 4
PACKAGE—60 PIN SIP MODULE WITH ZIP TERMINAL CONFIGURATION
PIN ASSIGNMENTS—Fig. 4.2–4

### – 70 PIN ZIP/SIMM SRAM MODULE

CAPACITY—64K, 256K, 1M WORDS OF 9 BITS
CONFIGURATION—SINGLE BANK MODULE USING DEVICES WITH 64K, 256K, OR 1M WORDS—SELECTABLE AS 64K, 256K, OR 1M BY 9
LOGIC FEATURE—SEPARATELY CONTROLLABLE BIT FOR USE AS PARITY BIT
PACKAGE—70 PIN SIP MODULE WITH ZIP TERMINAL CONFIGURATION
PIN ASSIGNMENTS—Fig. 4.2–5

| PHYSICAL CONFIGURATION | 4 DEVICES LONG | | | | 8 OR 9 DEVICES LONG | | | |
|---|---|---|---|---|---|---|---|---|
| | SINGLE BANK | | DOUBLE BANK | | SINGLE BANK | | | DOUBLE BANK |
| VERSION | N X 4 | @ 4N X 1 | 2N X 4 | N X 8 | * N X 8(9) | * N X 8(9) | 16M X 8 | * 2N X 8(9) |
| [1] 1 | $ A8 | VSS | ** NC | % NC | VDD | VDD | VDD | VDD |
| [2] 2 | VDD | VDD | A8 | A8 | $\overline{CE}$ | $\overline{CE}$ | $\overline{CE}$ | $\overline{CE}$ |
| [3] 3 | D0 | $\overline{RE0}$ | VDD | VDD | DQ0 | DQ0 | DQ0 | DQ0 |
| [4] 4 | Q0 | Q | D0 | DQ0 | A0 | A0 | A0 | A0 |
| [5] 5 | $\overline{CE}$ | A3 | Q0 | DQ1 | A1 | A1 | A1 | A1 |
| [6] 6 | A7 | A6 | $\overline{CE}$ | $\overline{CE}$ | DQ1 | DQ1 | DQ1 | DQ1 |
| [7] 7 | A5 | D | A7 | A7 | A2 | A2 | A2 | A2 |
| [8] 8 | A4 | $\overline{W}$ | A5 | A5 | A3 | A3 | A3 | A3 |
| [9] 9 | D1 | $\overline{RE1}$ | A4 | A4 | VSS | VSS | VSS | VSS |
| [10] 10 | Q1 | A0 | D1 | DQ2 | DQ2 | DQ2 | DQ2 | DQ2 |
| [11] 11 | $\overline{W}$ | A7 | Q1 | DQ3 | A4 | A4 | A4 | A4 |
| [12] 12 | A1 | A8 | $\overline{W}$ | $\overline{W}$ | A5 | A5 | A5 | A5 |
| [13] 13 | A3 | $\overline{CE}$ | A1 | A1 | DQ3 | DQ3 | DQ3 | DQ3 |
| [14] 14 | A6 | $\overline{RE2}$ | A3 | A3 | A6 | A6 | A6 | A6 |
| [15] 15 | Q2 | A2 | A6 | A6 | A7 | A7 | A7 | A7 |
| [16] 16 | D3 | A1 | Q2 | DQ4 | DQ4 | DQ4 | DQ4 | DQ4 |
| [17] 17 | A2 | @ A9 | D2 | DQ5 | A8 | A8 | A8 | A8 |
| [18] 18 | A0 | A4 | A2 | A2 | * A9 | * A9 | A9 | * A9 |
| [19] 19 | $\overline{RE}$ | $\overline{RE3}$ | A0 | A0 | * A10 | NC | A10 | $\overline{RE2}$ |
| [20] 20 | D3 | A5 | $\overline{RE1}$ | $\overline{RE}$ | DQ5 | DQ5 | DQ5 | DQ5 |
| [21] 21 | Q0 | VDD | D3 | DQ6 | $\overline{W}$ | $\overline{W}$ | $\overline{W}$ | $\overline{W}$ |
| [22] 22 | VSS | VSS | Q3 | DQ7 | VSS | VSS | VSS | VSS |
| [23] 23 | | | VSS | VSS | DQ6 | DQ6 | DQ6 | DQ6 |
| [24] 24 | | | *** $\overline{RE2}$ | NC | # NC · | PD1 | A11 | PD1 |
| [25] 25 | | | | | DQ7 | DQ7 | DQ7 | DQ7 |
| [26] 26 | | | | | Q8 | PD2 | NC | PD2 |
| [27] 27 | | | | | $\overline{RE}$ | $\overline{RE}$ | $\overline{RE}$ | $\overline{RE1}$ |
| [28] 28 | | | | | $\overline{CE8}$ | NC | NC | NC |
| [29] 29 | | | | | D8 | DQ8 | NC | DQ8 |
| [30] 30 | | | | | VDD | VDD | VDD | VDD |

TOP VIEW

* ON THE 30 PIN MODULE, 1M & 4M DEVICES MAY BE USED. PINS 18 & 19 ARE USED TO PROVIDE ADDRESS EXPANSION. THE OTHER MODULES WILL ACCOMIDATE 64K & 256K DEVICES ONLY.

** OPTIONAL VSS

*** NC FOR SINGLE BANK VERSION

$ OPTIONAL VSS WHEN A8 NOT NEEDED

# OPTIONAL REFRESH (F) FUNCTION

@ ON THE 22 PIN 4N X 1 MODULE, 1 MB & 4 MB DEVICES MAY BE USED. PIN 17 IS USED FOR ADDRESS EXPANSION

% POTENTIAL VSS

| PRESENCE DETECT TRUTH TABLE | | | |
|---|---|---|---|
| SIZE | 256K | 512K | 1M |
| PIN | | | |
| PD1 | L | H | L |
| PD2 | H | L | L |

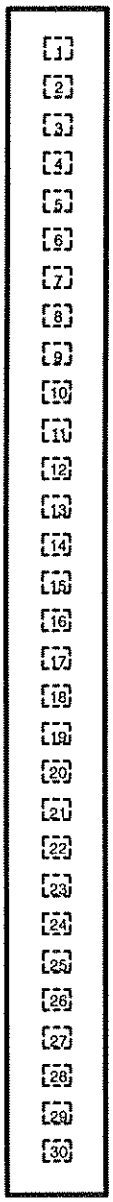
CONFIGURATION DEFINES THE PHYSICAL ARRANGEMENTS OF THE MEMORY DEVICES ON THE MODULE, GIVING LENGTH AND NUMBER OF SIDES POPULATED.

VERSION IS THE LOGIC ORGANIZATION OF THE MODULE WHERE "N" IS THE CAPACITY OF THE MEMORY DEVICE USED.

## FIGURE 4.2–1

## 22, 24,& 30 PIN DRAM MODULES

| PHYSICAL CONFIGURATION | 4 OR 5 DEVICES LONG SINGLE SIDED | | | 4 OR 5 DEVICES LONG DOUBLE SIDED | | |
|---|---|---|---|---|---|---|
| VERSION | N X 4(5) | 2N X 2 | 4N X 1 | 2N X 4(5) | 4N X 2 | 8N X 1 |
| 1 | VDD | | | | | |
| 2 | D4 | NC | NC | D4 | NC | NC |
| 3 | Q4 | NC | NC | Q4 | NC | NC |
| 4 | A8 | | | | | |
| 5 | A9 | | | | | |
| 6 | *A10 | | | | | |
| 7 | D3 | D1 | NC | D3 | D1 | NC |
| 8 | Q3 | Q1 | NC | Q3 | Q1 | NC |
| 9 | VSS | | | | | |
| 10 | A6 | | | | | |
| 11 | A7 | | | | | |
| 12 | A2 | | | | | |
| 13 | A1 | | | | | |
| 14 | D2 | NC | D | D2 | NC | D |
| 15 | Q2 | NC | Q | Q2 | NC | Q |
| 16 | A4 | | | | | |
| 17 | A5 | | | | | |
| 18 | A3 | | | | | |
| 19 | A0 | | | | | |
| 20 | D1 | D0 | NC | D1 | D0 | NC |
| 21 | Q1 | Q0 | NC | Q1 | Q0 | NC |
| 22 | VSS | | | | | |
| 23 | $\overline{W}$ | | | | | |
| 24 | $\overline{CE}$ | $\overline{CE1}$ | | | | |
| 25 | NC | $\overline{CE2}$ | | | | |
| 26 | $\overline{RE}$ | | | $\overline{RE1}$ | | |
| 27 | NC | NC | NC | $\overline{RE2}$ | | |
| 28 | D0 | NC | $\overline{CE3}$ | D0 | NC | $\overline{CE3}$ |
| 29 | Q0 | NC | $\overline{CE4}$ | Q0 | NC | $\overline{CE4}$ |
| 30 | VDD | | | | | |



30 PIN SIP MODULE TOP VIEW

* PIN 6 RESERVED FOR OPTIONAL REFRESH (F) WHEN NOT NEEDED FOR A10

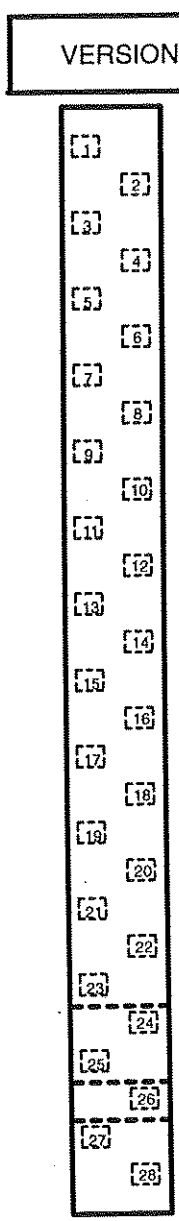
CONFIGURATION DEFINES THE PHYSICAL ARRANGEMENTS OF THE MEMORY DEFICES ON THE MODULE, GIVING LENGTH AND NUMBER OF SIDES POPULATED

VERSION IS THE LOGIC ORGANIZATION OF THE MODULE WHERE "N" IS THE CAPACITY OF THE MEMORY DEVICE USED

MEMORY DEVICES WITH A CAPACITY OF UP TO 4Mb BY 1 CAN BE ACCOMIDATED ON THE MODULES DEFINED IN THIS STANDARD

**FIGURE 4.2–2**

**30 PIN DRAM MODULE FAMILY**




23, 25, 26, OR 28
PIN ZIP SIMM
TOP VIEW

| VERSION | @ N X 1 | # N X 1 | & N X 4 | % N X 4 |
|---|---|---|---|---|
| 1 | VSS | VSS | VSS | VSS |
| 2 | $\overline{RE0}$ | $\overline{RE0}$ | QO | QO |
| 3 | $\overline{RE1}$ | $\overline{RE1}$ | D0 | D0 |
| 4 | * A10 | A10 | Q0 | Q0 |
| 5 | * A9 | A9 | D1 | D1 |
| 6 | A0 | A0 | * A10 | A10 |
| 7 | A1 | A1 | * A9 | A9 |
| 8 | A2 | A2 | A0 | A0 |
| 9 | A3 | A3 | A1 | A1 |
| 10 | VCC | VCC | A2 | A2 |
| 11 | D | D | A3 | A3 |
| 12 | Q | Q | VCC | VCC |
| 13 | $\overline{W}$ | $\overline{W}$ | $\overline{RE}$ | $\overline{RE}$ |
| 14 | $\overline{CE}$ | $\overline{CE}$ | $\overline{CE}$ | $\overline{CE}$ |
| 15 | VCC | VCC | $\overline{W}$ | $\overline{W}$ |
| 16 | A4 | A4 | VCC | VCC |
| 17 | A5 | A5 | A4 | A4 |
| 18 | A6 | A6 | A4 | A4 |
| 19 | A7 | A7 | A6 | A6 |
| 20 | A8 | A8 | A7 | A7 |
| 21 | $\overline{RE2}$ | A11 | A8 | A8 |
| 22 | $\overline{RE3}$ | NC | D2 | A11 |
| 23 | VSS | $\overline{RE2}$ | Q2 | NC |
| 24 | | $\overline{RE3}$ | D3 | D2 |
| 25 | | VSS | Q3 | Q2 |
| 26 | | | VSS | D3 |
| 27 | | | | Q3 |
| 28 | | | | VSS |

N = THE ADDRESS CAPACITY OF THE MEMORY DEVICE USED

@ THIS CONFIGURATION IS APPLICABLE TO 1M, 4M, & 16M X 1 DEVICES.

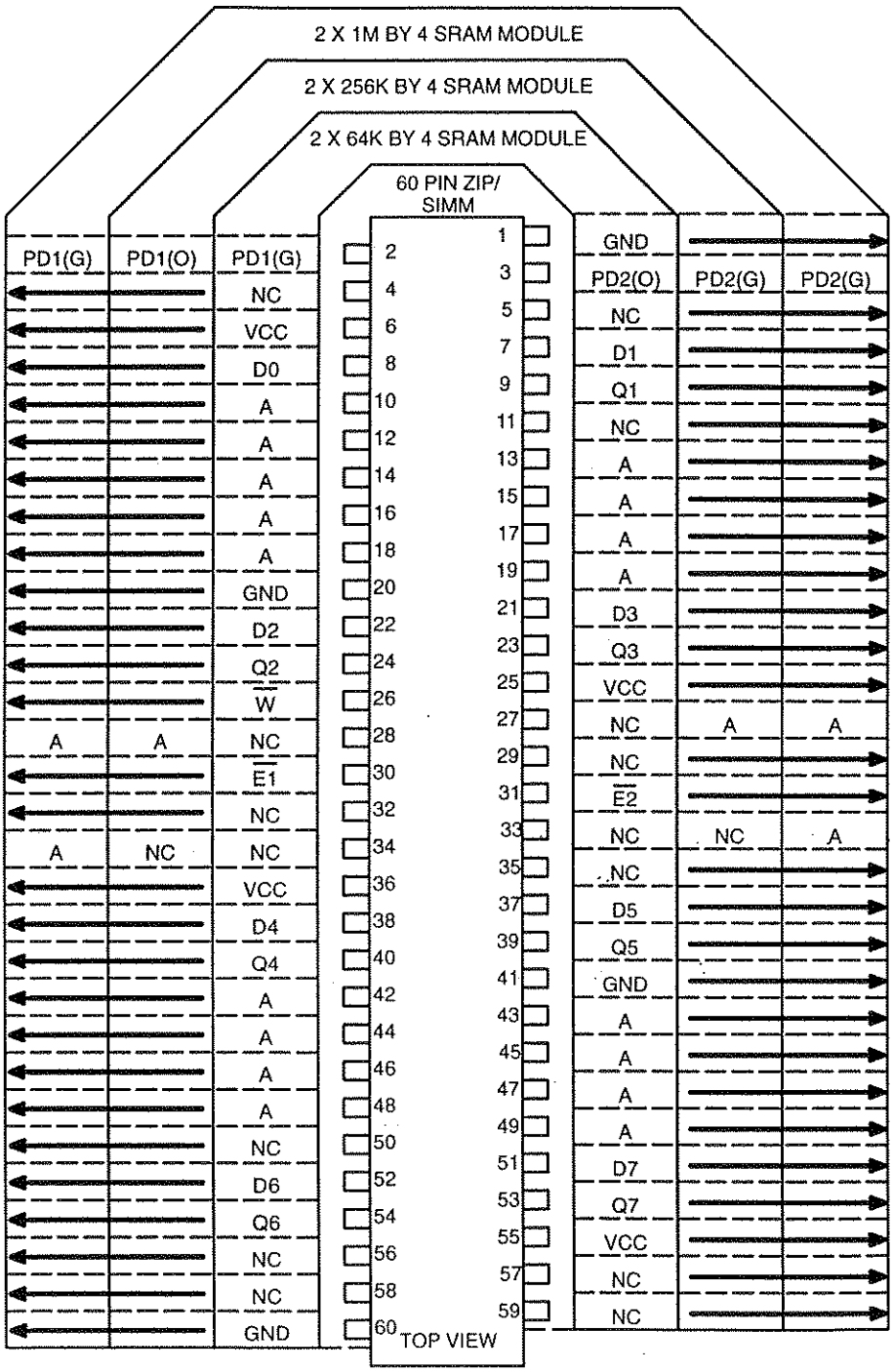
# THIS CONFIGURATION IS APPLICABLE TO A 64M X 1 DEVICE

& THIS CONFIGURATION IS APPLICABLE TO 256K, 1M, & 4M X 4 DEVICES.

% THIS CONFIGURATION IS APPLICABLE TO A 16M X 4 DEVICE

* THESE ADDRESS PINS ARE NC WHEN NOT NEEDED FOR THE MEMORY DEVICE USED.

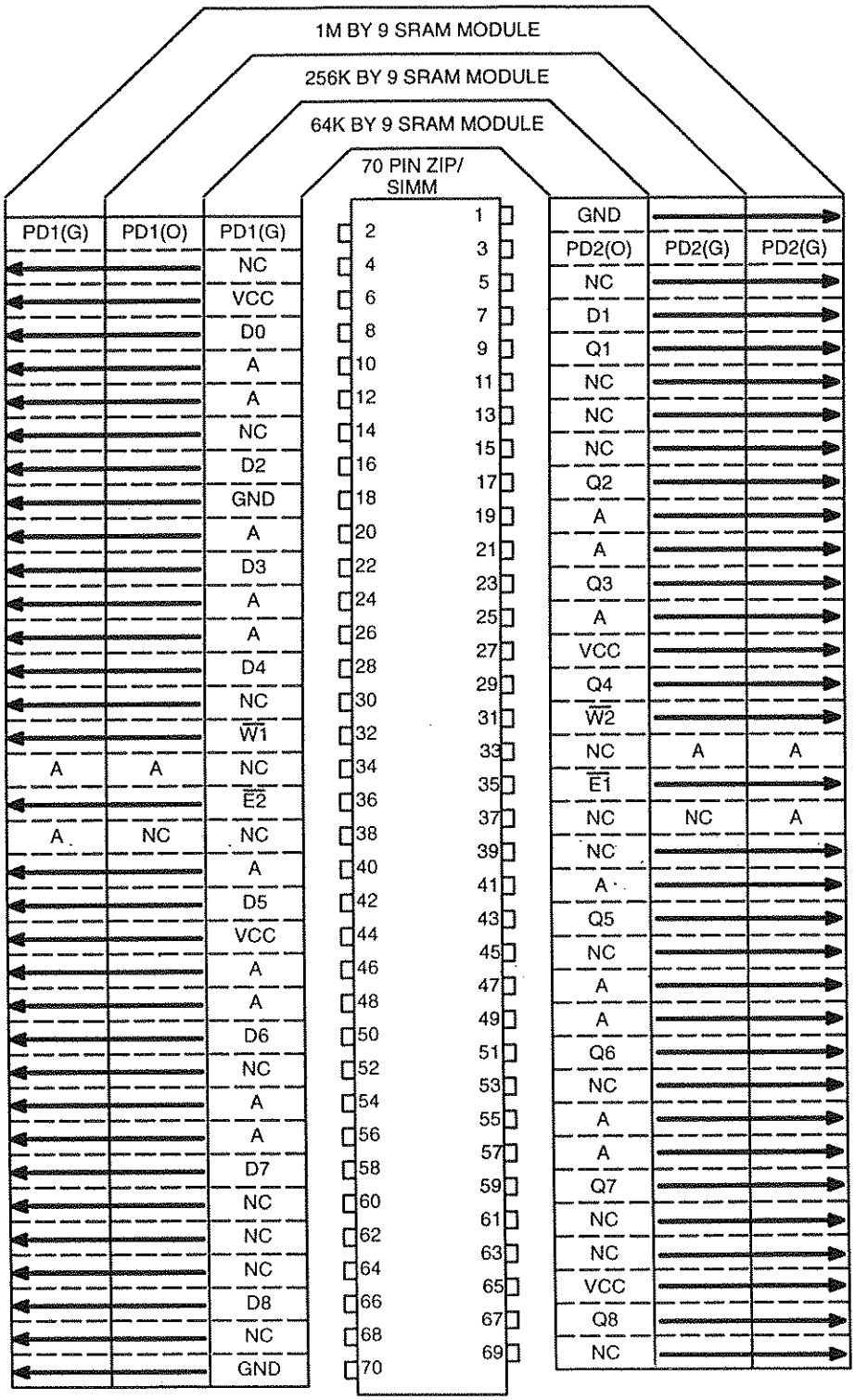
## FIGURE 4.2–3
## 23/25/26/28 PIN DRAM MODULE FAMILY




The PD(n) pins are connected to GND (G) or left open (O).

E1 ENABLES Q0, Q2, Q4, & Q6
E2 ENABLES Q1, Q3, Q5, & Q7

## FIGURE 4.2–4
## 2 X 64K TO 1M BY 4, 60 PIN SRAM MODULE FAMILY




The PD(n) pins are connected to GND (G) or left optn (O).

E1 & W1 CONTROL Q0, Q1, Q2, Q3, Q5, Q6, Q7, Q8
E2 & W2 CONTROL Q4

**FIGURE 4.2–5**

**64K TO 1M BY 9, 70 PIN SRAM MODULE FAMILY**

## 4.3 Two Byte Modules & Cards

### 4.3.1 – 76 PIN ZIP/SIMM SRAM MODULE

CAPACITY—2 X 64K, 2 X 256K, 2 X 1M WORDS OF 9 BITS
CONFIGURATION—DUAL BANK MODULE USING DEVICES WITH 64K, 256K, OR 1M WORDS—SELECTABLE AS 64K, 256K, OR 1M BY 18
128K, 512K, OR 2M BY 9
LOGIC FEATURE—2 SEPARATELY CONTROLLABLE BITS FOR USE AS PARITY BITS
PACKAGE—76 PIN SIP MODULE WITH ZIP TERMINAL CONFIGURATION
PIN ASSIGNMENTS—Fig. 4.3–1

### 4.3.2 – 40 PIN SIP/SIMM DRAM MODULE FAMILY

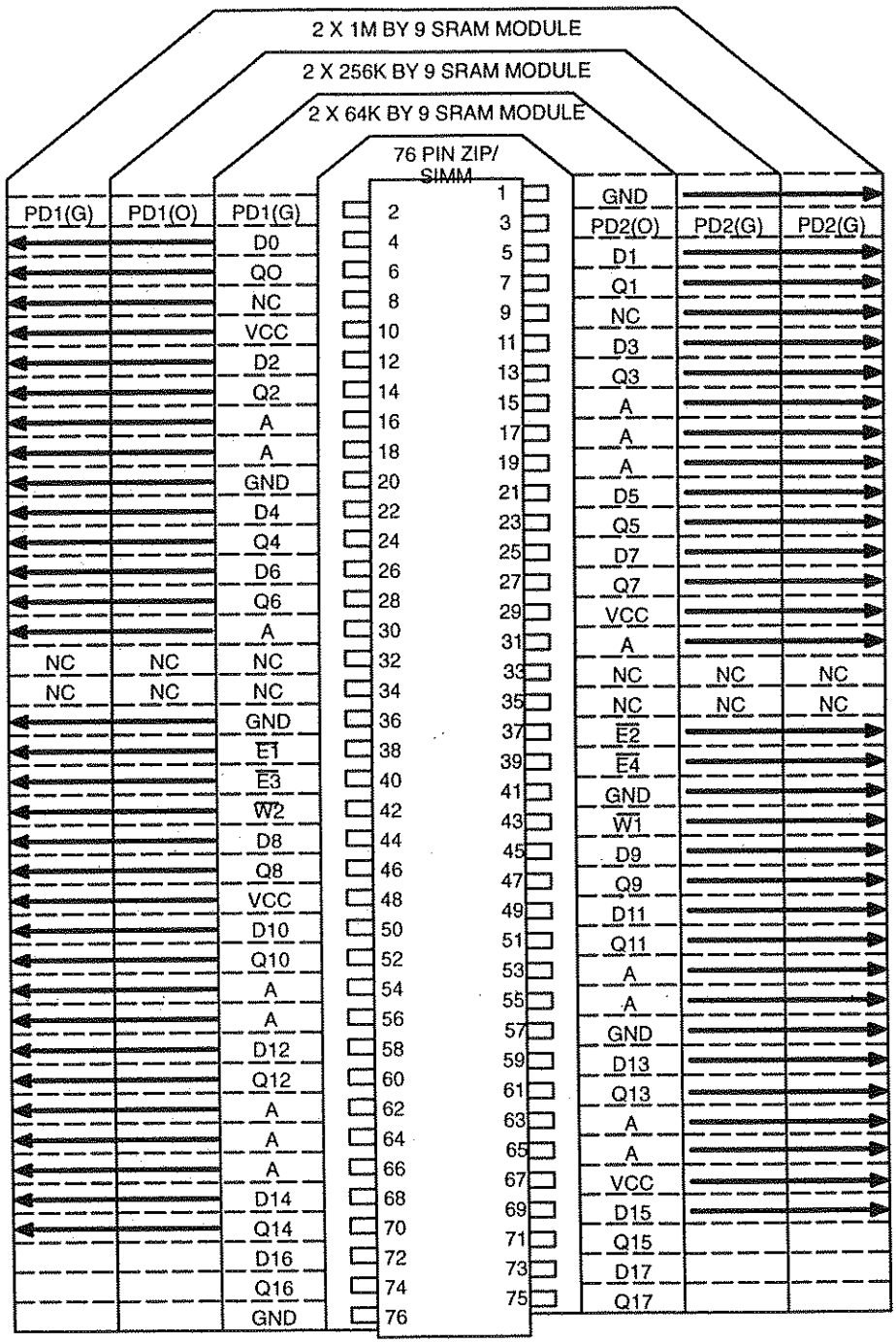
CAPACITY —64K TO 4M WORDS OF 16 OR 18 BITS
—64K TO 8M WORDS OF 8 OR 9 BITS
—128K TO 16M WORDS OF 4 BITS
—256K TO 32M WORDS OF 2 BITS
—512K TO 64M WORDS OF 1 BIT
CONFIGURATION—ONE OR TWO SIDED,
—USING 64K, 256K, 1M, OR 4M DEVICES
PACKAGE—40 PIN SIP MODULE
PIN ASSIGNMENTS—Fig. 4.3–2

### 4.3.3 – 60 PIN DRAM CARD FAMILY

CAPACITY—512K, 1M, 2M, 4M, & 8M WORDS OF 16 OR 18 BITS
CONFIGURATION—SEVEN DIFFERENT CONFIGURATIONS
—USING 1Mb & 4Mb DEVICES AND WITH 1, 2, OR 4 RE CLOCKS.
LOGIC FEATURES, The cards contain a "PRESENCE DETECT" feature which conists of output pins which supply an encoded value which defines the storage capacity, configuration, and speed of the card.
PACKAGE—60 PIN JEDEC MEMORY CARD
PIN ASSIGNMENTS—Fig. 4.3–3A
CONFIGURATION BLOCK DIAGRAMS—Fig. 4.3–3B

### 4.3.4 – 68 PIN MULTIPLE TECHNOLOGY MEMORY CARD FAMILY

CAPACITY—UP TO 32M WORDS OF 16 BITS
CONFIGURATION—ONE BASIC CONFIGURATION that allows the use of SRAM, EEPROM, EPROM, or ROM memory devices with software or firmware control to accomidate the device characteristic differences.
LOGIC FEATURES,
—The card contains an internal MEMORY called the "ATTRIBUTE MEMORY"; the contents describe the hardware and software characteristics, and use of the card.
— The card contains a "PRESENCE DETECT" feature which conists of output pins which supply an encoded value which defines the storage capacity, configuration, and speed of the card.
PACKAGE—68 PIN JEDEC MEMORY CARD
PIN ASSIGNMENTS—Fig. 4.3–4A
MEMORY CARD OPERATION TRUTH TABLE— Page 4.3–4B
MEMORY CARD SPECIFIC TERMINOLOGY— Sec. 2.8, Page 2–13

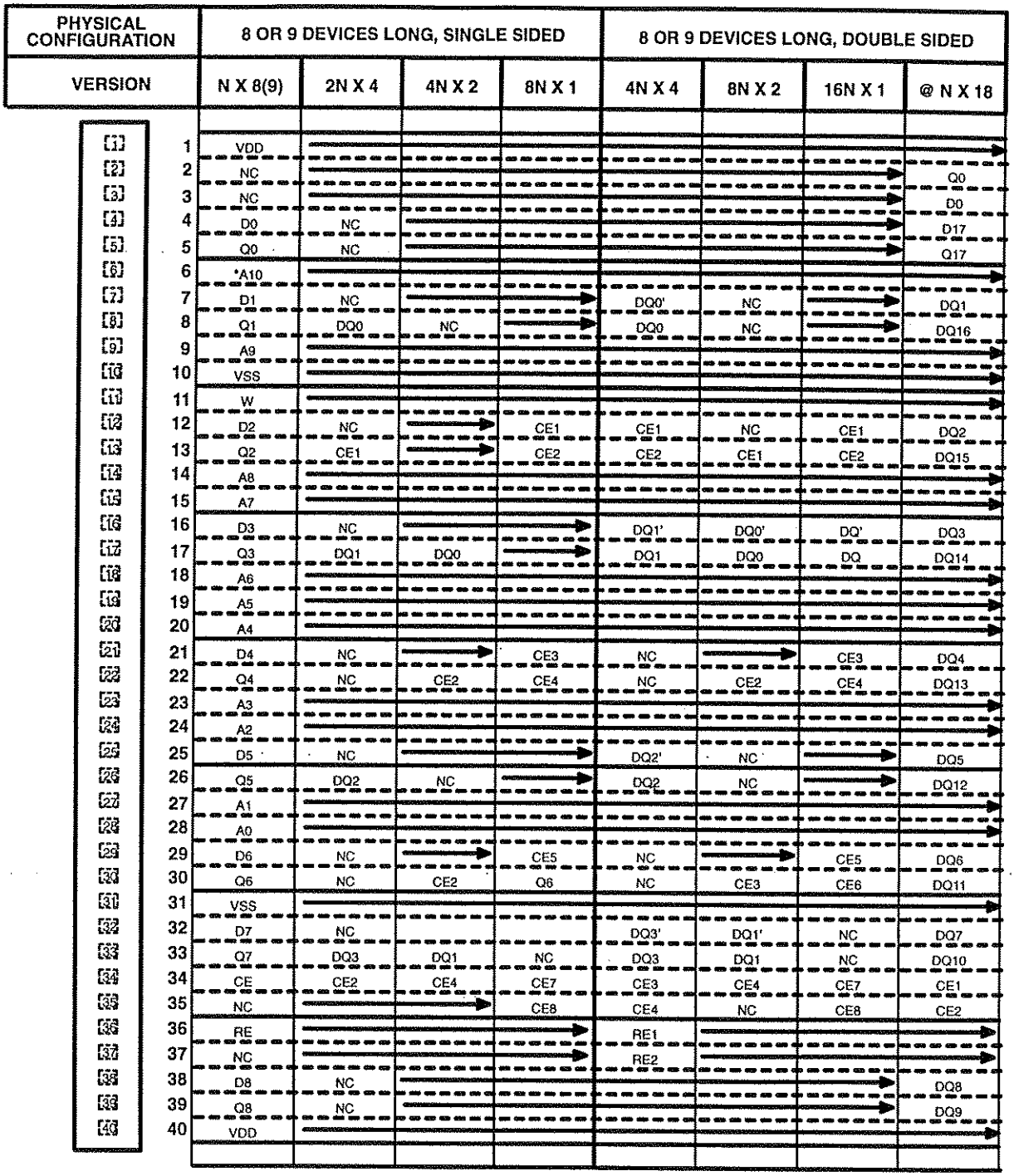



The PD(n) pins are connected to GND (G) or left optn (O).

E1 & W1 CONTROL Q0, Q2, Q4, Q6, Q10, Q12, Q14, Q16
E2 & W1 CONTROL Q1, Q3, Q5, Q7, Q11, Q13, Q15, Q17
E3 & W2 CONTROL Q8
E4 & W2 CONTROL Q9

**FIGURE 4.3–1**

**2 X 64K TO 1M BY 9, 76 PIN SRAM MODULE FAMILY**




40 PIN SIP MODULE TOP VIEW

* PIN 5 RESERVED FOR OPTIONAL REFRESH (F) WHEN NOT NEEDED FOR A10

@ N X 18 MODULE CAN BE USED AS A 2N X 9 BY CONNECTING ADJACENT D, Q, & DQ PINS TOGETHER

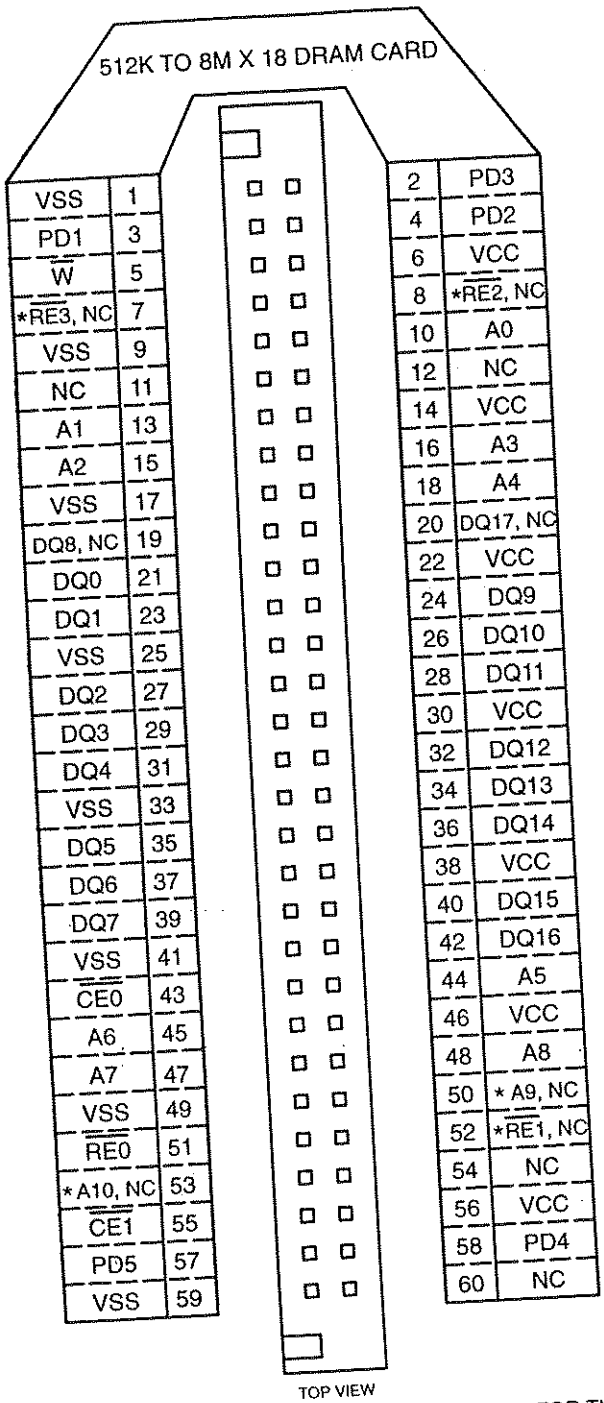
CONFIGURATION GIVES THE PHYSICAL ARRANGEMENTS OF THE MEMORY DEVICES ON THE MODULE GIVING LENGTH AND NUMBER OF SIDED POPULATED, VERSION IS THE LOGIC ORGANIZATION OF THE MODULE WHERE "N" IS THE CAPACITY OF THE MEMORY DEVICE USED.

THOSE PIN NAMES LABELED "'" (PRIME) ARE CONNECTED TO THE BACK SIDE OF THE MODULE ON THE DOUBLE SIDED CONFIGURATIONS.

## FIGURE 4.3–2
## 40 PIN DRAM MODULE FAMILY



XILINX EXHIBIT 1012
Page 220




* SEE TABLE FOR FUNCTION ASSIGNMENTS FOR THESE PINS AS A FUNCTION OF CARD CAPACITY AND CONFIGURATION

| | PD4 | PD5 |
|---|---|---|
| SPEED (tRAC) | 58 | 57 |
| 80 NS | VSS | VSS |
| 70 NS | VSS | NC |
| 60 NS | NC | VSS |
| 50 NS | NC | NC |

PD SPEED TABLE

| | PD1 | PD2 | PD3 |
|---|---|---|---|
| CONFIGURATION | 3 | 4 | 2 |
| 512K X 16/18 2 $\overline{RE}$ | VSS | NC | VSS |
| 1M X 16/18 4 $\overline{RE}$ | VSS | NC | NC |
| 2M X 16/18 2 $\overline{RE}$ | NC | VSS | VSS |
| 4M X 16/18 4 $\overline{RE}$ | NC | VSS | NC |
| 1M X 16/18 1 $\overline{RE}$ | VSS | VSS | VSS |
| 4M X 16/18 1 $\overline{RE}$ | NC | NC | VSS |
| 8M X 16/18 2 $\overline{RE}$ | VSS | VSS | NC |
| NO CARD | NC | NC | NC |

PD CONFIGURATION TABLE

| | PIN NUMBER | | | | |
|---|---|---|---|---|---|
| CONFIGURATION | 50 | 53 | 52 | 8 | 7 |
| 512K X 16/18 2 $\overline{RE}$ | NC | NC | RE1 | NC | NC |
| 1M X 16/18 4 $\overline{RE}$ | NC | NC | RE1 | RE2 | RE3 |
| 2M X 16/18 2 $\overline{RE}$ | A9 | NC | RE1 | NC | NC |
| 4M X 16/18 4 $\overline{RE}$ | A9 | NC | RE1 | RE2 | RE3 |
| 1M X 16/18 1 $\overline{RE}$ | A9 | NC | NC | NC | NC |
| 4M X 16/18 1 $\overline{RE}$ | A9 | A10 | NC | NC | NC |
| 8M X 16/18 2 $\overline{RE}$ | A9 | A10 | RE1 | NC | NC |

CONFIGURATION PIN ASSIGNMENT TABLE

Pins 19 & 20 (DQ8 & DQ 17) are NC for X16 Versions

## FIGURE 4.3–3A
## 60 PIN x16 or 18 DRAM CARD FAMILY PIN CONNECTIONS

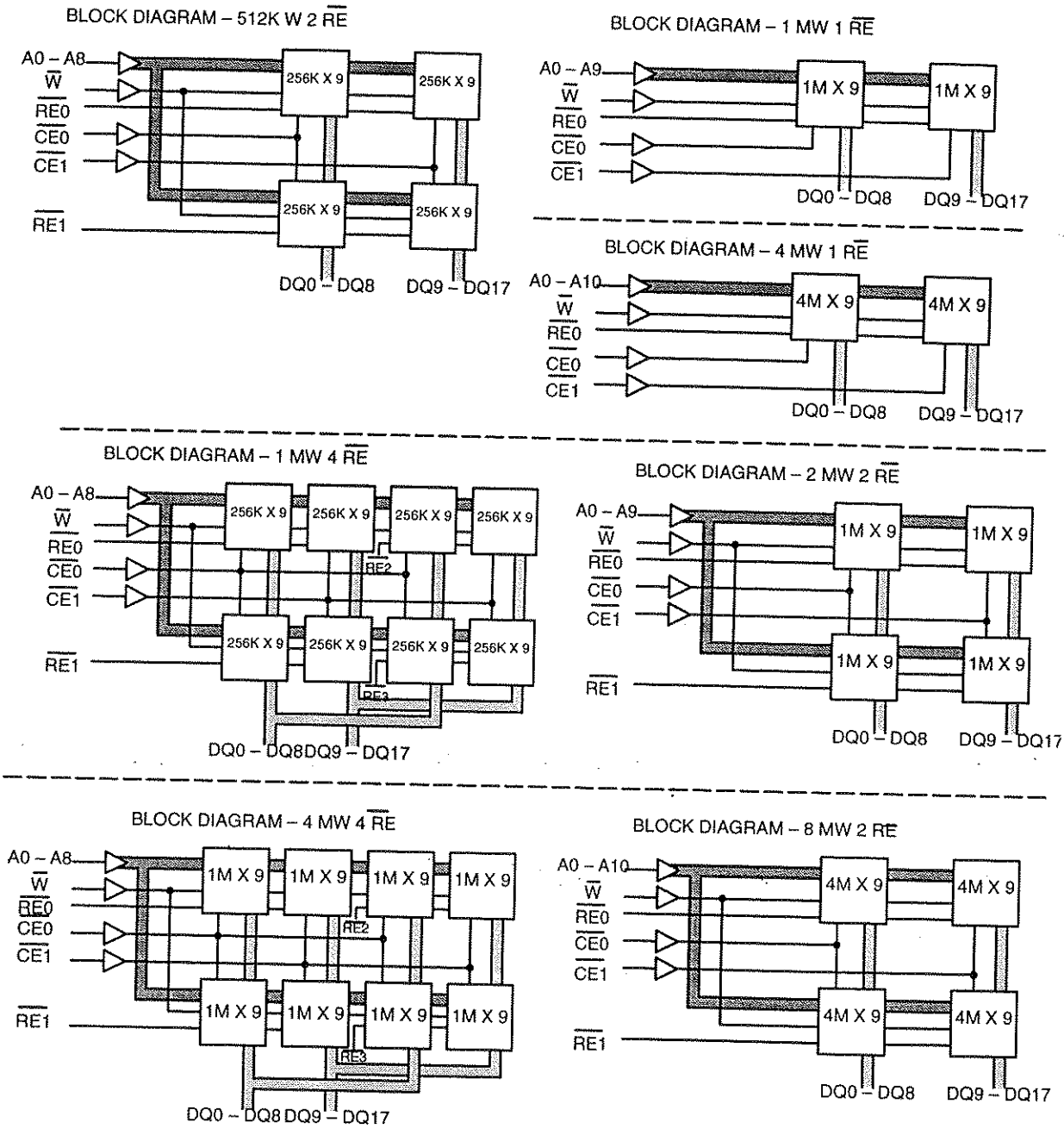
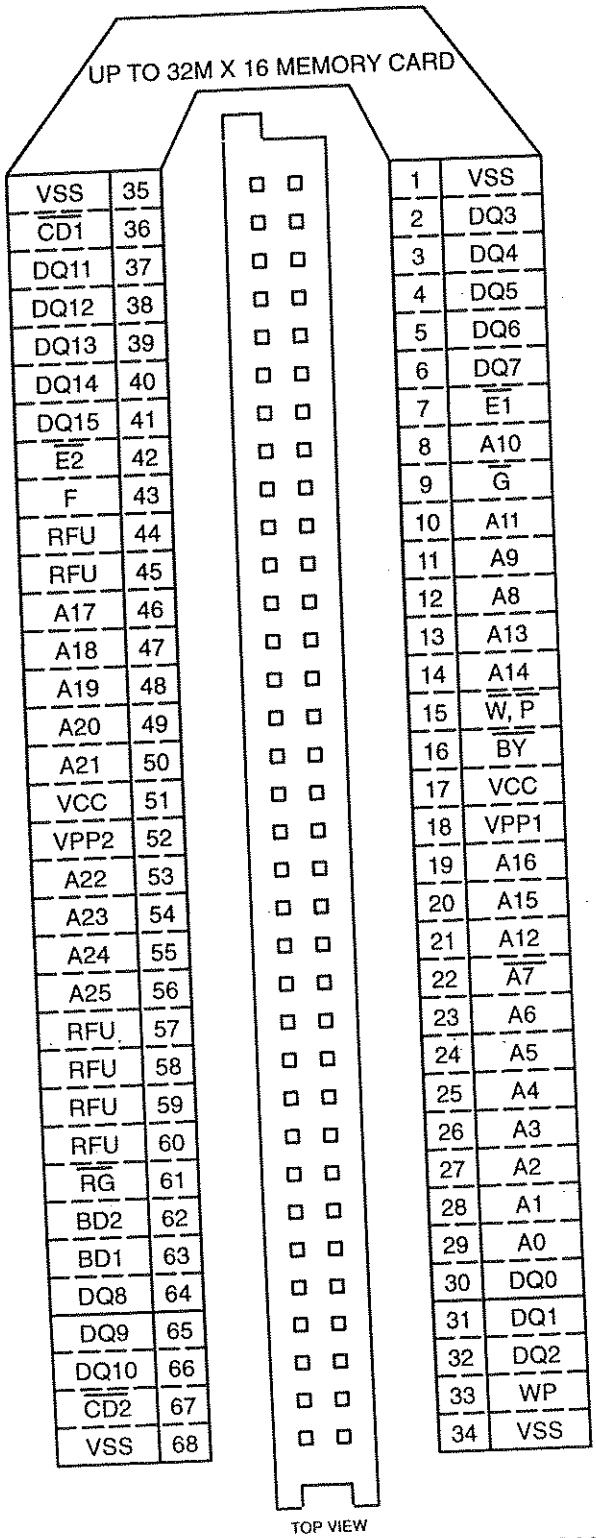



**FIGURE 4.3–3B**
**60 PIN x16 or 18 DRAM CARD FAMILY BLOCK DIAGRAMS**




* NOTE: This Standard is applicable to SRAM, EPROM, OTPROM, EEPROM, and FLASH Memory. It is not applicable to DRAM.

**FIGURE 4.3–4A**

**68 PIN MULTIPLE TECHNOLOGY CARD FAMILY**

| Main Memory Read Function for all types of Memory Card except DRAM | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MODE | $\overline{RG}$ | $\overline{E2}$ | $\overline{E1}$ | A0 | $\overline{G}$ | $\overline{W}$ | VPP2 | VPP1 | DQ15–DQ8 | DQ7–DQ0 |
| Standby Mode | X | H | H | X | X | X | VCC | VCC | High–Z | High–Z |
| Byte Access (8 bits) | H | H | L | L | L | H | VCC | VCC | High–Z | Even–Byte |
| | H | H | L | H | L | H | VCC | VCC | High–Z | Odd–Byte |
| Word Access (16 bits) | H | L | L | X | L | H | VCC | VCC | Odd–Byte | Even–Byte |
| Odd–Byte Only Access | H | L | H | X | L | H | VCC | VCC | Odd–Byte | High–Z |
| Main Memory Write Function for SRAM and EEPROM | | | | | | | | | | |
| MODE | $\overline{RG}$ | $\overline{E2}$ | $\overline{E1}$ | A0 | $\overline{G}$ | $\overline{W}$ | VPP2 | VPP1 | DQ15–DQ8 | DQ7–DQ0 |
| Standby Mode | X | H | H | X | X | X | VCC | VCC | XXX | XXX |
| Byte Access (8 bits) | H | H | L | L | H | L | VCC | VCC | XXX | Even–Byte |
| | H | H | L | H | H | L | VCC | VCC | XXX | Odd–Byte |
| Word Access (16 bits) | H | L | L | X | H | L | VCC | VCC | Odd–Byte | Even–Byte |
| Odd–Byte Only Access | H | L | H | X | H | L | VCC | VCC | Odd–Byte | High–Z |
| Main Memory Write Function for OTPROM, EPROM, and FLASH Memory | | | | | | | | | | |
| MODE | $\overline{RG}$ | $\overline{E2}$ | $\overline{E1}$ | A0 | $\overline{G}$ | $\overline{W}$ | VPP2 | VPP1 | DQ15–DQ8 | DQ7–DQ0 |
| Standby Mode | X | H | H | X | X | X | VCC, VPP | VCC, VPP | XXX | XXX |
| Byte Access (8 bits) | H | H | L | L | H | L | VCC | VPP | XXX | Even–Byte |
| | H | H | L | H | H | L | VPP | VCC | XXX | Odd–Byte |
| Word Access (16 bits) | H | L | L | X | H | L | VPP | VPP | Odd–Byte | Even–Byte |
| Odd–Byte Only Access | H | L | H | X | H | L | VPP | VCC | Odd–Byte | XXX |
| Attribute Memory Read Function | | | | | | | | | | |
| MODE | $\overline{RG}$ | $\overline{E2}$ | $\overline{E1}$ | A0 | $\overline{G}$ | $\overline{W}$ | VPP2 | VPP1 | DQ15–DQ8 | DQ7–DQ0 |
| Standby Mode | X | H | H | X | X | X | VCC | VCC | High–Z | High–Z |
| Byte Access (8 bits) | L | H | L | L | L | H | VCC | VCC | High–Z | Even–Byte |
| | L | H | L | H | L | H | VCC | VCC | High–Z | Not Valid |
| Word Access (16 bits) | L | L | L | X | L | H | VCC | VCC | Not Valid | Even–Byte |
| Odd–Byte Only Access | L | L | H | X | L | H | VCC | VCC | Not Valid | High–Z |
| Attribute Memory Write Function for SRAM and EEPROM | | | | | | | | | | |
| MODE | $\overline{RG}$ | $\overline{E2}$ | $\overline{E1}$ | A0 | $\overline{G}$ | $\overline{W}$ | VPP2 | VPP1 | DQ15–DQ8 | DQ7–DQ0 |
| Standby Mode | X | H | H | X | X | X | VCC | VCC | XXX | XXX |
| Byte Access (8 bits) | L | H | L | L | H | L | VCC | VCC | XXX | Even–Byte |
| | L | H | L | H | H | L | VCC | VCC | XXX | XXX |
| Word Access (16 bits) | L | L | L | X | H | L | VCC | VCC | XXX | Even–Byte |
| Odd–Byte Only Access | L | L | H | X | H | L | VCC | VCC | XXX | XXX |
| Attribute Memory Write Function for OTPROM, EPROM, and FLASH Memory | | | | | | | | | | |
| MODE | $\overline{RG}$ | $\overline{E2}$ | $\overline{E1}$ | A0 | $\overline{G}$ | $\overline{W}$ | VPP2 | VPP1 | XXX | DQ7–DQ0 |
| Standby Mode | X | H | H | X | X | X | VCC, VPP | VCC, VPP | XXX | XXX |
| Byte Access (8 bits) | L | H | L | L | H | L | VCC | VPP | XXX | Even–Byte |
| | L | H | L | H | H | L | VCC | VCC | XXX | XXX |
| Word Access (16 bits) | L | L | L | X | H | L | VPP | VPP | XXX | Even–Byte |
| Odd–Byte Only Access | L | L | H | X | H | L | VPP | VCC | XXX | XXX |

NOTE: For those pins in the above tables where "VCC, VPP" is specified, either supply may be used for programming at the option of the manufacturer. However those cards which use VCC must be able to withstand VPP without damage.

**FIGURE 4.3–4B**

**68 PIN MULTIPLE TECHNOLOGY CARD FAMILY FUNCTION TABLES**

## 4.4 Four Byte Modules & Cards

4.4.1 – 64 & 72 PIN ZIP/SIMM SRAM MODULE

4.4.2 – 72 PIN SIMM DRAM MODULE FAMILY

– 72 PIN SIMM DRAM ECC MODULE FAMILY

4.4.3 – 88 PIN DRAM CARD FAMILY

4.4.4 – 72 PIN DRAM SO–DIMM FAMILY

4.4.5 – 88 PIN DRAM SO–DIMM FAMILY

4.4.6 – 112 PIN MPDRAM DIMM FAMILY

4.4.7 – 80 PIN EEPROM SIMM FAMILY

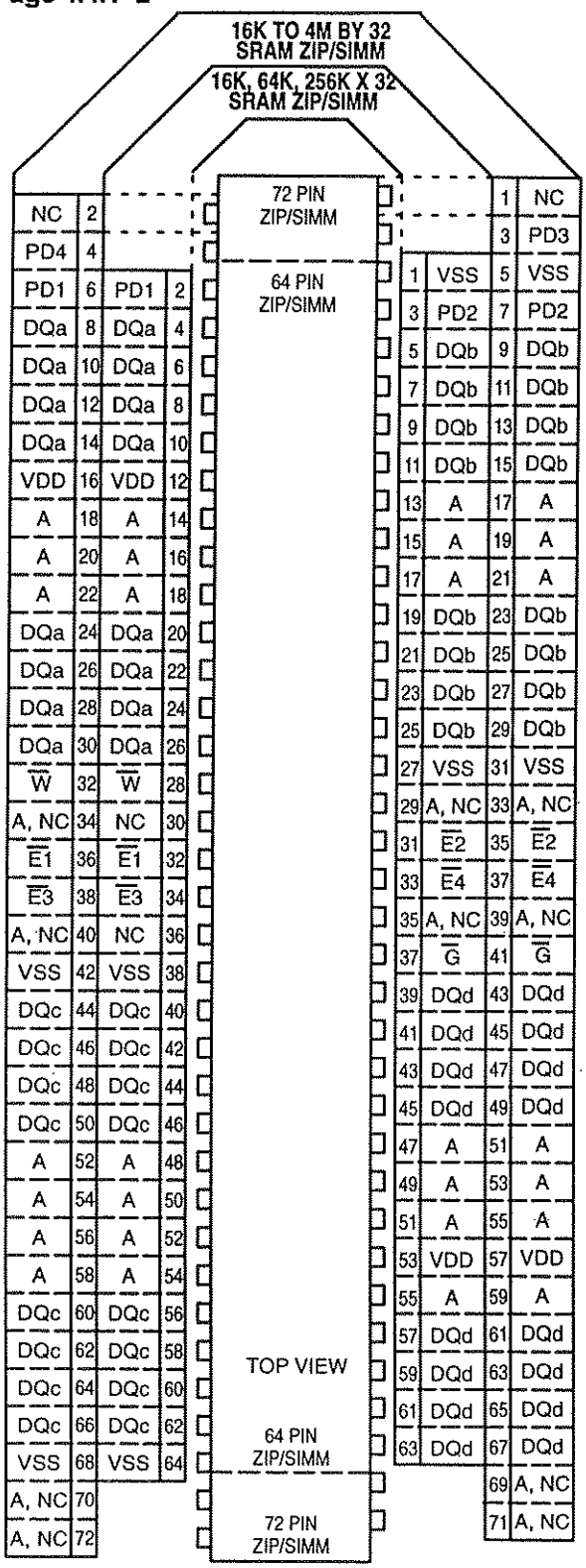
4.4.8 – 100 PIN DRAM, SDRAM & ROM DIMM FAMILY

## 4.4.1 – 64 & 72 PIN ZIP/SIMM SRAM MODULE

CAPACITY—16K, 32K, 64K, 128K, 256K, 512K, 1M, 2M, or 4M WORDS OF 32 BITS
CONFIGURATION—FOUR BANK MODULE
—SELECTABLE BY BYTE GROUPS
LOGIC FEATURE—The 72 pin modules are supersets of the 64 pin family with added capacity.
PACKAGE—64 and 72 PIN SIP MODULEWITH ZIP TERMINAL CONFIGURATION
PIN ASSIGNMENTS—Fig. 4.4.1–1



XILINX EXHIBIT 1012
Page 227




NOTES for 72–pin ZIP/SIMM module pinout:
1. $\overline{E1}$ enables DQa pins 8, 10, 12, 14, and 24, 26, 28, 30; $\overline{E2}$ enables DQb pins 9, 11, 13, 15, and 23, 25, 27, 29; $\overline{E3}$ enables DQc pins 44, 46, 48, 50, and 60, 62, 64, 66; $\overline{E4}$ enables DQd pins 43, 45, 47, 49, and 61, 63, 65, 67.
2. $\overline{W}$ enables writing into all enabled devices.
3. $\overline{G}$ enables outputs from any and all enabled devices.
4. This footprint is a superset of the 64–pin JEDEC standard. Any 64 pin JEDEC standard module may be used in the 72–pin footprint. PD3 and PD4 become NC (OPEN) in this case.
5. Two pins (1 & 2) are available for future definition.

**PRESENCE DETECT TRUTH TABLE**

| MOD CONFIG | PD4 | PD3 | PD2 | PD1 |
|---|---|---|---|---|
| 72P MOD | PIN 68 | PIN 67 | PIN 66 | PIN 11 |
| # 16K X 32 | O | O | O | S |
| 32K X 32 | S | S | O | O |
| # 64K X 32 | O | O | S | O |
| 128K X 32 | S | O | O | O |
| # 256K X 32 | O | O | S | S |
| 512K X 32 | O | S | O | O |
| 1M X 32 | O | S | O | S |
| 2M X 32 | O | S | S | O |
| 4M X 32 | O | S | S | S |

O = OPEN CIRCUIT (NO CONNECTION)
S = CONNECTED TO VSS

# Indicates configurations duplicated in 64P package. Use PD1 & PD2 only.

PRESENCE DETECT NOTES
1. Compatibility has been maintained with existing 64–pin standard
2. PD signature has been added for 32K X 32 & 128K X 32 configurations that were not implemented in the 64–pin standard.
3. Six PD signatures are left undefined for future definition.

**ADDRESS PIN ASSIGNMENTS**

| CONFIGURATION | ADDRESS PIN NUMBER | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 72 P MODULES | 33 | 34 | 40 | 39 | 69 | 70 | 71 | 72 |
| 16K X 32 | NC | NC | NC | NC | NC | NC | NC | NC |
| 32K X 32 | A | NC | NC | NC | NC | NC | NC | NC |
| 64K X 32 | A | A | NC | NC | NC | NC | NC | NC |
| 128K X 32 | A | A | A | NC | NC | NC | NC | NC |
| 256K X 32 | A | A | A | A | NC | NC | NC | NC |
| 512K X 32 | A | A | A | A | A | NC | NC | NC |
| 1M X 32 | A | A | A | A | A | A | NC | NC |
| 2M X 32 | A | A | A | A | A | A | A | NC |
| 4M X 32 | A | A | A | A | A | A | A | A |
| 64 P MODULES | 29 | 30 | 35 | 36 | | | | |
| 16K X 32 | NC | NC | NC | NC | | | | |
| 64K X 32 | A | A | NC | NC | | | | |
| 256K X 32 | A | A | A | A | | | | |

## FIGURE 4.4.1–1
## 16K TO 4M BY 32 SRAM ZIP/SIMM MODULE

**NOTE:** The 72 pin module standards that follow describe two separate devices. Both have a 4 byte data interface. One is intended to be used with or without parity bits while the other contains error correction bits ECC). The one with ECC is similar to the parity module but is not completely pin compatible

## 4.4.2 – 72 PIN SIMM DRAM MODULE FAMILY

CAPACITY—256K TO 512M WORDS OF 32 or 36 BITS
CONFIGURATION—SINGLE OR DOUBLE SIDED MODULES
—USING 1M, 4M, 16M. 64M, or 256M MEMORY DEVICES
LOGIC FEATURES, These modules contain a "presence detect" feature which conists of output pins which supply an encoded value which defines the storage capacity and speed of the module.
PACKAGE—72 PIN SIMM MODULE
PIN ASSIGNMENTS—Fig. 4.4.2–2A
BLOCK DIAGRAMS—Fig. 4.4.2–2 A⇒K. A series of block diagrams for recommended configurations is summarized in Fig 4.4.2–1 and detailed in Figs. 4.4.2–2 B⇒K
POWER & INTERFACE VOLTAGE LEVELS: A pinout is provided for 5.0 V and for 3.3 V power and interface levels as defined by a voltage key in the socket.

## – 72 PIN SIMM DRAM ECC MODULE FAMILY

CAPACITY—256K TO 512M WORDS OF 36 or 39 BITS
CONFIGURATION—SINGLE OR DOUBLE SIDED MODULES
—USING 1M, 4M, 16M. 64M, or 256M MEMORY DEVICES
LOGIC FEATURES, These modules are optimized for ECC applications. They are similar to but not the same as the modules described in Fig. 4–6. The Standard defines a "presence detect" feature which consists of output pins which supply an encoded value which defines the storage capacity and speed of the module. The PD code identifies the presence of an ECC module as well as the speed and organization of the module. The Standard also defines the logic organization of the modules in Figs. 4.4.2–3B & 4.4.2–3C.
PACKAGE—72 PIN SIMM MODULE
PIN ASSIGNMENTS—Fig. 4.4.2–3A
BLOCK DIAGRAMS—Figs. 4.4.2–3 B & C. A series of block diagrams for recommended configurations is summarized in Fig 4.4.2–1 and detailed in Figs. 4.4.2–3 B & C
POWER & INTERFACE VOLTAGE LEVELS: A pinout is provided for 5.0 V and for 3.3 V power and interface levels as defined by a voltage key in the socket.

## 72 Pin SIMM Block Diagrams

The block diagrams given in the 12 pages, Figs 4.4.2–2 B ⇒ K and Figs 4.4.2–3 B & C), are applicable to the 72 Pin SIMM pinouts shown in Figures 4.4.2–2 A and 4.4.2–3 A. These block diagrams are provided for guidance only. **Other implementations with different block configurations are also acceptable**.

The following table shows the applicability of the block configurations given to the 5 V and 3.3 V Non–ECC and ECC modules.

| Configuration | # Banks | Applies to: 5 V SIMM | Applies to: 3.3 V SIMM |
|---|---|---|---|
| **Parity, Non–Parity** | | | |
| X32/36 W/X4, X1 (X36) | 1 or 2 | X | X |
| X32/36 W/X16, X18 | 1 or 2 | X | X |
| X36 W/X4, X4/4CE | 1 or 2 | X | X |
| X36 W/X4, X2/2CE | 1 or 2 | X | X |
| X36 W/X16, X4/4CE | 1 or 2 | X | X |
| X36 W/X16, X2/2CE | 1 or 2 | X | X |
| X32 W/X8 | 1 or 2 | | X |
| X36 W/X8, X2/2CE | 1 or 2 | | X |
| X32 W/X32 | 1 or 2 | | X |
| X36 W/X32, X2/2CE | 1 or 2 | | X |
| **ECC** | | | |
| X36/40 W/X4 | 1 or 2 | X | X (X36 only) |

**Note: To reduce the number of diagrams, only 2 bank versions are shown. In addition, in cases where one SIMM I/O width can be described as a depopulation of another SIMM (i.e. X36⇒X32), the depopulated devices are shown by a "dashed" outline.**

| $\overline{RE}$ AND $\overline{G}$ WIRING FOR BYTE WRITE SIMMS. | | |
|---|---|---|
| SIGNAL NAME | 5 V SIMMs | 3.3 V SIMMs |
| $\overline{G}$ | Tied to GND | Wired to Pin 46 |
| $\overline{RE0}$ | Connected as shown. Tied to pin 44 ($\overline{RE0}$) | $\overline{RE0}$, $\overline{RE2}$ nets connected together and tied to pin 44 ($\overline{RE0}$) |
| $\overline{RE1}$ | Connected as shown. Tied to pin 45 ($\overline{RE1}$) | $\overline{RE1}$, $\overline{RE3}$ nets connected together and tied to pin 45 ($\overline{RE1}$) |
| $\overline{RE2}$ | Connected as shown. Tied to pin 34 ($\overline{RE2}$) | $\overline{RE0}$, $\overline{RE2}$ nets connected together and tied to pin 44 ($\overline{RE0}$) |
| $\overline{RE3}$ | Connected as shown. Tied to pin 33 ($\overline{RE3}$) | $\overline{RE1}$, $\overline{RE3}$ nets connected together and tied to pin 45 ($\overline{RE1}$) |

**FIGURE 4.4.2–1**
**72 PIN DRAM SIMM APPLICABILITY TABLE**

| | 5 V Byte Write | 3.3 V Byte Write |
|---|---|---|
| PIN # | PIN NAME | PIN NAME |
| 1 | VSS | VSS |
| 2 | DQ0 | DQ0 |
| 3 | DQ18 | DQ18 |
| 4 | DQ1 | DQ1 |
| 5 | DQ19 | DQ19 |
| 6 | DQ2 | DQ2 |
| 7 | DQ20 | DQ20 |
| 8 | DQ3 | DQ3 |
| 9 | DQ21 | DQ21 |
| 10 | VDD | VDD |
| 11 | NU | PD5 |
| 12 | A0 | A0 |
| 13 | A1 | A1 |
| 14 | A2 | A2 |
| 15 | A3 | A3 |
| 16 | A4 | A4 |
| 17 | A5 | A5 |
| 18 | A6 | A6 |
| 19 | NC, A10 | NC, A10 |
| 20 | DQ4 | DQ4 |
| 21 | DQ22 | DQ22 |
| 22 | DQ5 | DQ5 |
| 23 | DQ23 | DQ23 |
| 24 | DQ6 | DQ6 |
| 25 | DQ24 | DQ24 |
| 26 | DQ7 | DQ7 |
| 27 | DQ25 | DQ25 |
| 28 | A7 | A7 |
| 29 | NC, A11 | NC, A11 |
| 30 | VDD | VDD |
| 31 | A8 | A8 |
| 32 | NC, A9 | NC, A9 |
| 33 | NC, $\overline{RE3}$ | NC, A12 |
| 34 | $\overline{RE2}$ | NC, A13 |
| 35 | PDQ26, NC | PDQ26, NC |
| 36 | PDQ8, NC | PDQ8, NC |

| | 5 V Byte Write | 3.3 V Byte Write |
|---|---|---|
| PIN # | PIN NAME | PIN NAME |
| 37 | PDQ17, NC | PDQ17, NC |
| 38 | PDQ35,, NC | PDQ35,, NC |
| 39 | VSS | VSS |
| 40 | $\overline{CE0}$ | $\overline{CE0}$ |
| 41 | $\overline{CE2}$ | $\overline{CE2}$ |
| 42 | $\overline{CE3}$ | $\overline{CE3}$ |
| 43 | $\overline{CE1}$ | $\overline{CE1}$ |
| 44 | $\overline{RE0}$ | $\overline{RE0}$ |
| 45 | NC, $\overline{RE1}$ | NC, $\overline{RE1}$ |
| 46 | NC | $\overline{G}$ |
| 47 | $\overline{W}$ | $\overline{W}$ |
| 48 | PD(ECC) | PD(ECC) |
| 49 | DQ9 | DQ9 |
| 50 | DQ27 | DQ27 |
| 51 | DQ10 | DQ10 |
| 52 | DQ28 | DQ28 |
| 53 | DQ11 | DQ11 |
| 54 | DQ29 | DQ29 |
| 55 | DQ12 | DQ12 |
| 56 | DQ30 | DQ30 |
| 57 | DQ13 | DQ13 |
| 58 | DQ31 | DQ31 |
| 59 | VDD | VDD |
| 60 | DQ32 | DQ32 |
| 61 | DQ14 | DQ14 |
| 62 | DQ33 | DQ33 |
| 63 | DQ15 | DQ15 |
| 64 | DQ34 | DQ34 |
| 65 | DQ16 | DQ16 |
| 66 | NC | $\overline{EDO}$ |
| 67 | PD1 | PD1 |
| 68 | PD2 | PD2 |
| 69 | PD3 | PD3 |
| 70 | PD4 | PD4 |
| 71 | NC | PD(REF) |
| 72 | VSS | VSS |

**PRESENCE DETECT TRUTH TABLE**

| CONFIGURATION | tRAC | ECC | PD1 | PD2 | PD3 | PD4 |
|---|---|---|---|---|---|---|
| 1MB (256K X 36) 64MB (16M X 32/36) | 100 nS | O | S | O | S | S |
| | 80 nS | O | S | O | O | S |
| | 70 nS | O | S | O | S | O |
| | 60 nS | O | S | O | O | O |
| 2MB (512K X 36) 128MB (32M X 32/36) | 100 nS | O | O | S | S | S |
| | 80 nS | O | O | S | O | S |
| | 70 nS | O | O | S | S | O |
| | 60 nS | O | O | S | O | O |
| 4MB (1M X 36) 256MB (64M X 32/36) | 100 nS | O | S | S | S | S |
| | 80 nS | O | S | S | O | S |
| | 70 nS | O | S | S | S | O |
| | 60 nS | O | S | S | O | O |
| 8MB (2M X 36) 0.5GB (128M X 32/36) | 100 nS | O | O | O | S | S |
| | 80 nS | O | O | O | O | S |
| | 70 nS | O | O | O | S | O |
| | 60 nS | O | O | O | O | O |
| 16MB (4M X 36) 1GB (256M X 32/36) | 50 nS | O | S | O | S | S |
| | 80 nS | O | S | O | O | S |
| | 70 nS | O | S | O | S | O |
| | 60 nS | O | S | O | O | O |
| 32MB (8M X 36) 2GB (512M X 36) | 50 nS | O | O | S | S | S |
| | 80 nS | O | O | S | O | S |
| | 70 nS | O | O | S | S | O |
| | 60 nS | O | O | S | O | O |

O = NO CONNECTION S = CONNECTED TO VSS

$\overline{EDO}$ Pin: VSS for EDO, NC for Fast Page.

Note: The $\overline{ECC}$ Function (Pin 48) is not a defined function for the devices in this standard, however, it is used in a companion Standard for 72 pin ECC modules shown in Fig. 4–10. The presence of a VSS connection on this pin signifies that an ECC module has been inserted.

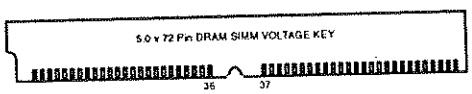
**CONFIGURATION PIN ASSIGNMENT TABLE**

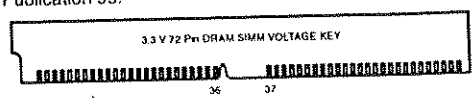
| | MODULE SIZE, 36 BIT WORDS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PIN # | 256K | 512K | 1M | 2M | 4M | 8M | 16M | 32M | 64M | 128M | 256M | 512M |
| 19 | NC | NC | NC | NC | A10 | A10 | A10 | A10 | A10 | A10 | A10 | A10 |
| *29 | NC | NC | NC | NC | A11 | A11 | A11 | A11 | A11 | A11 | A11 | A11 |
| 32 | NC | NC | A9 | A9 | A9 | A9 | A9 | A9 | A9 | A9 | A9 | A9 |
| *33 | NC | $\overline{RE3}$ | NC | $\overline{RE3}$ | NC | $\overline{RE3}$ | A12 | A12 | A12 | A12 | A12 | A12 |
| *34 | NC | $\overline{RE2}$ | NC | $\overline{RE2}$ | NC | $\overline{RE2}$ | NC | NC | A13 | A13 | A13 | A13 |
| 45 | NC | $\overline{RE1}$ | NC | $\overline{RE1}$ | NC | $\overline{RE1}$ | NC | $\overline{RE1}$ | NC | $\overline{RE1}$ | NC | RE1 |

* A11, A12, or A13 on Pins 29, 33, or 34 are used on modules containing devices that require asymetric ROW/ COLUMN addresses.

NOTE – This family of pinouts is approved for use in SIMM modules which are nominally 4.25" long and with a height which varies depencing on the configuration and the memory devices used. See JEDEC Publication 95.

See Figure 4–18 for applicable block diagrams




# FIGURE 4.4.2–2 A

# 256K TO 256M BY 36, 72 PIN DRAM MODULE PINOUT

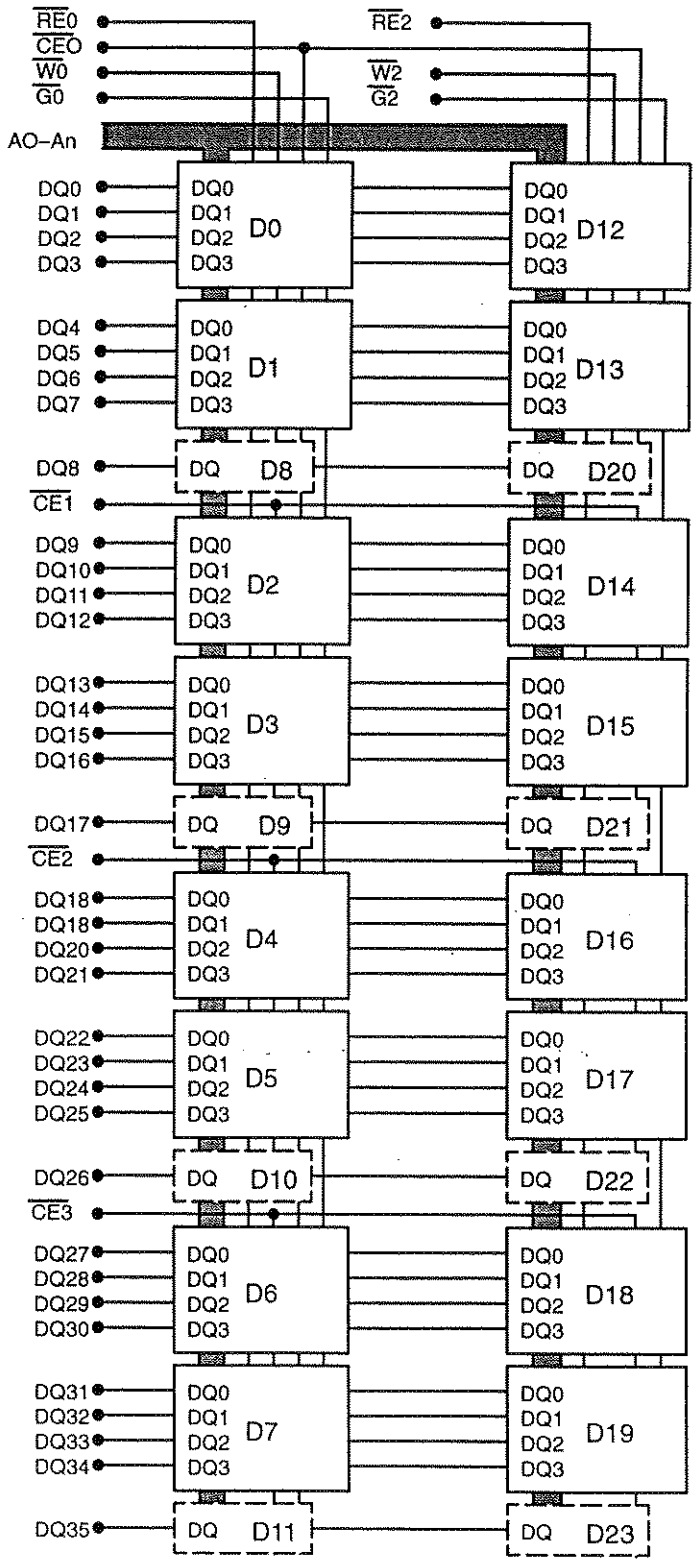
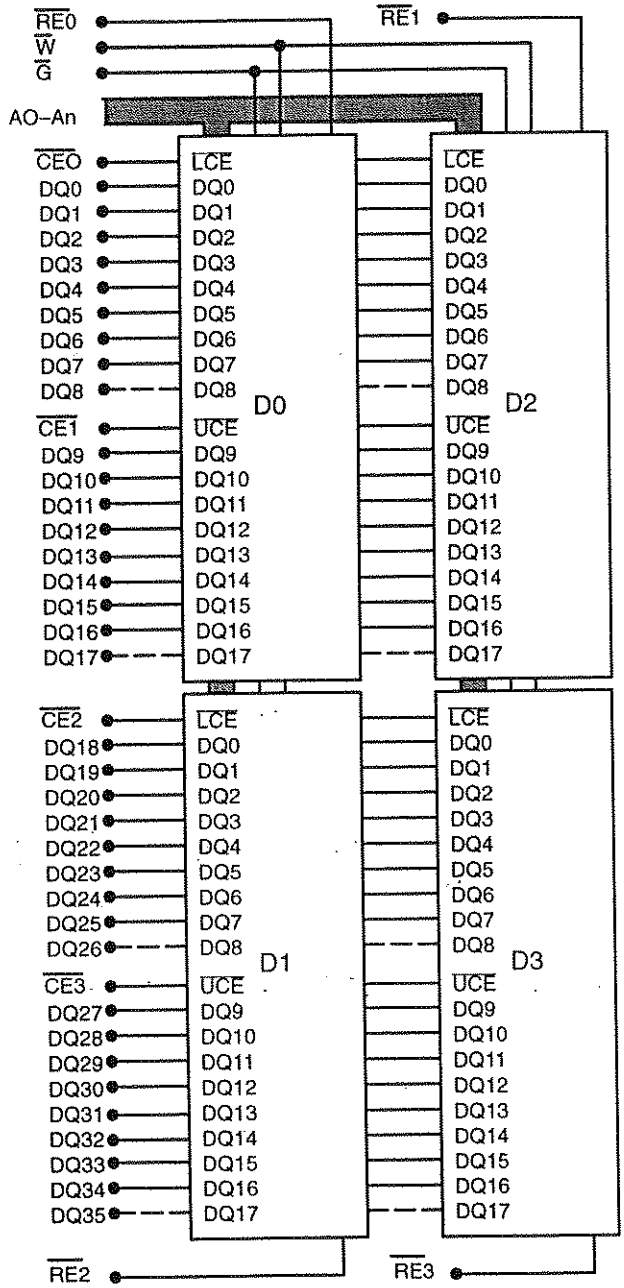



**FIGURE 4.4.2–2 B**
**X32/36 DRAM SIMM, 2 Banks with X4 & X1 DRAMs**

Release 6–7




DQ8, DQ17, DQ26, & DQ35 ARE NOT USED
ON THE X32 MODULE USING X16 DRAM

**FIGURE 4.4.2–2 C**
**X32/36 DRAM SIMM, 2 Banks with X16/18 DRAMs**

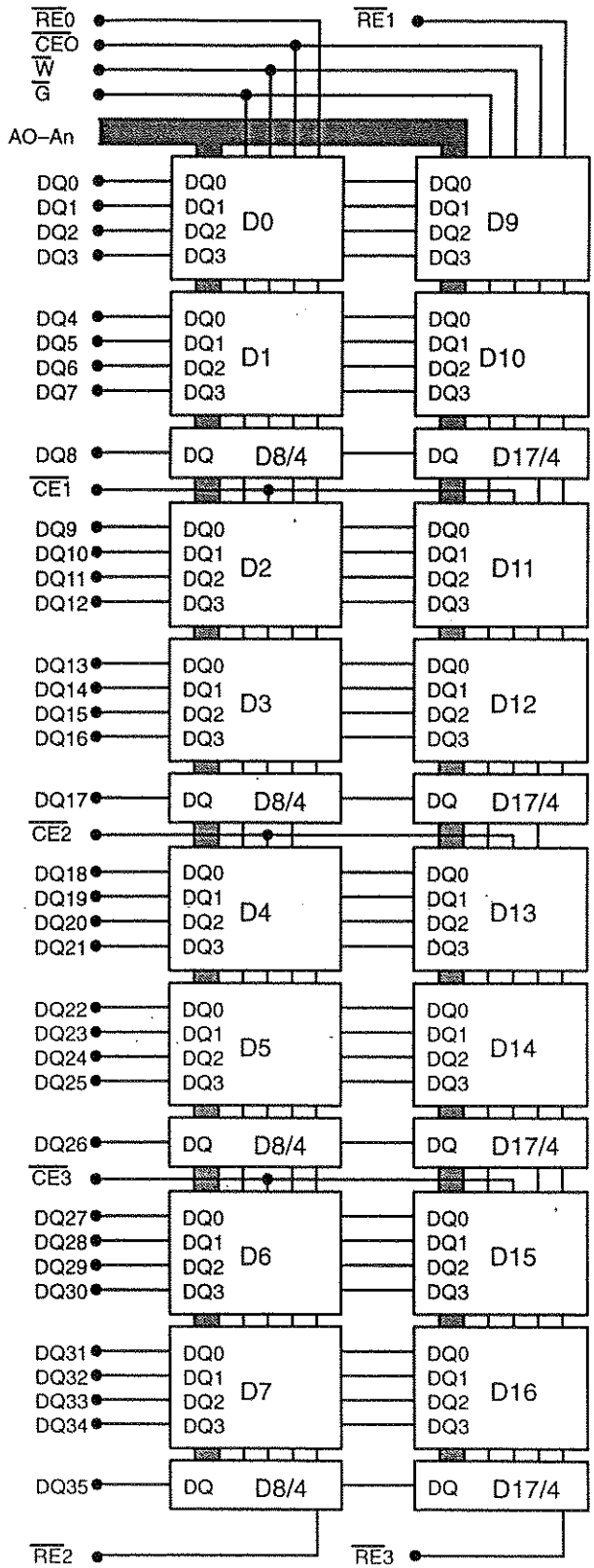



**FIGURE 4.4.2–2 D**
**X36 DRAM SIMM, 2 Banks with X4 & X4 W/4 $\overline{CE}$ DRAMs**

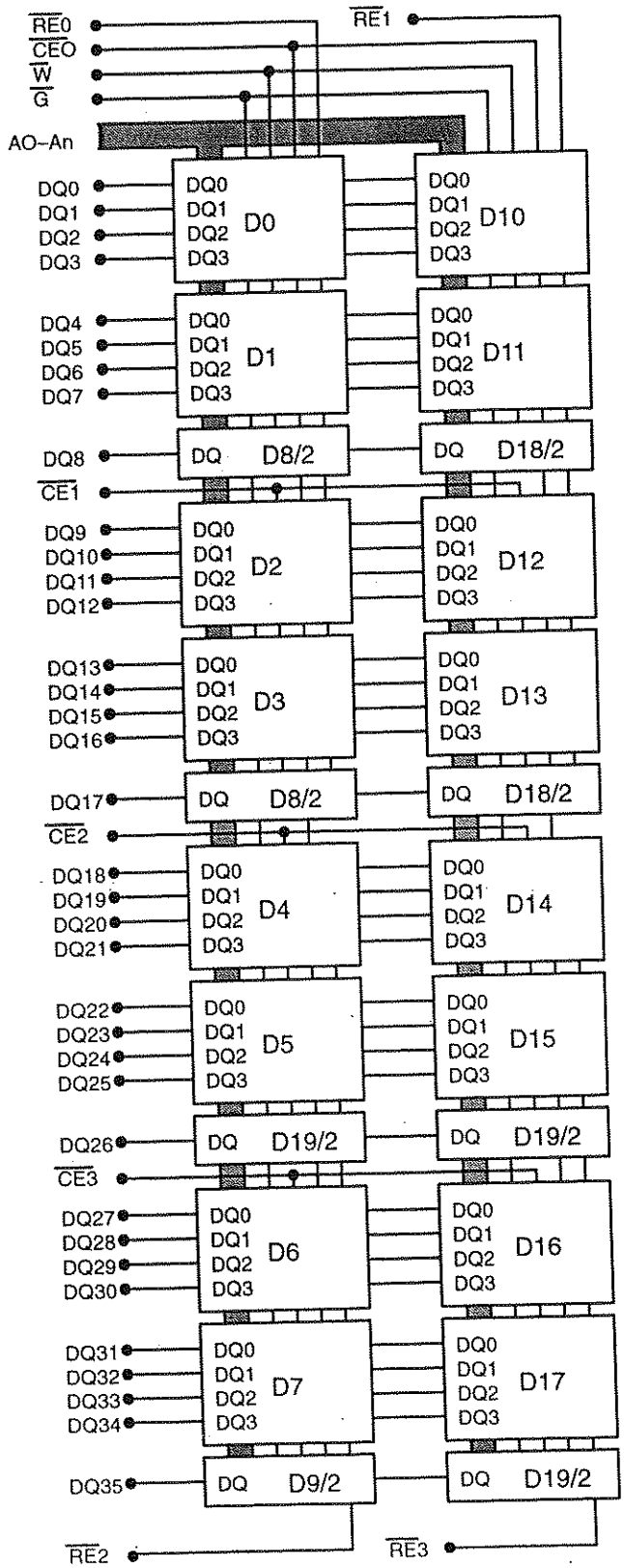



**FIGURE 4.4.2–2 E**

**X36 DRAM SIMM, 2 Banks with X4 & X2 W/2 $\overline{CE}$ DRAMs**

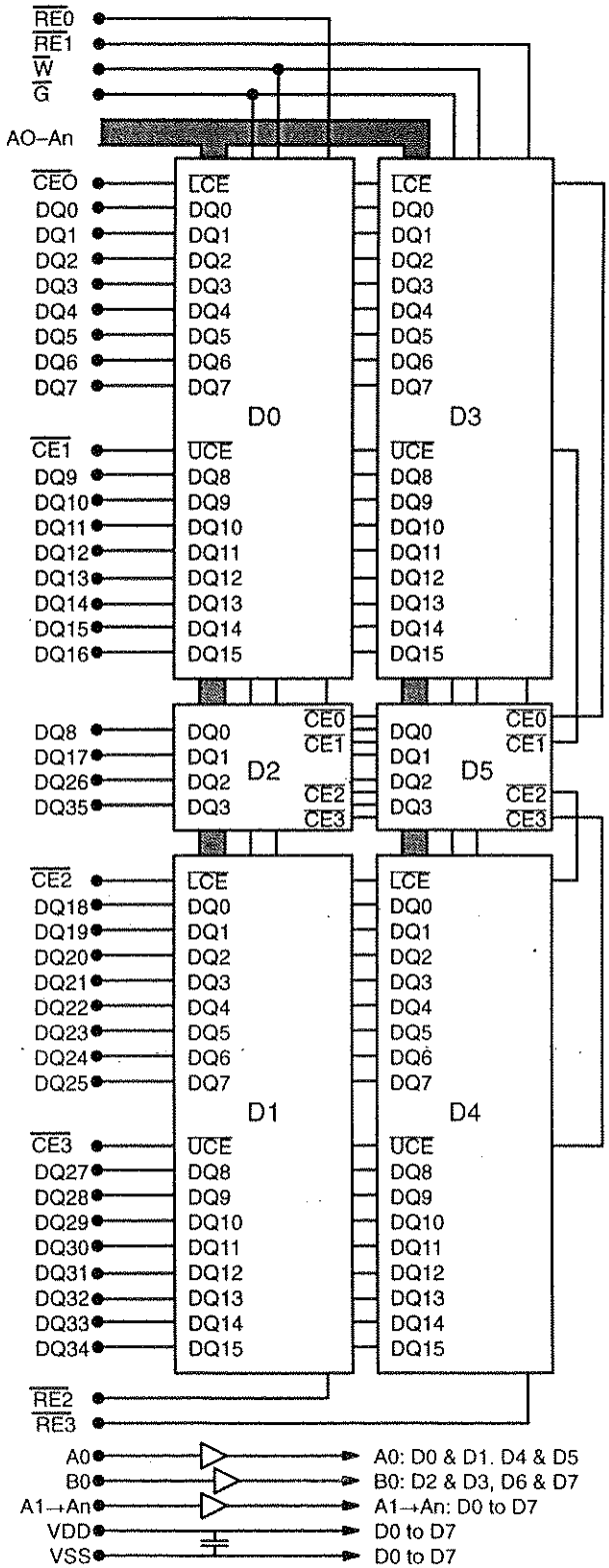



**FIGURE 4.4.2–2 F**
**X36 DRAM SIMM, 2 Banks with X16 & X4 W/4 $\overline{CE}$ DRAMs**

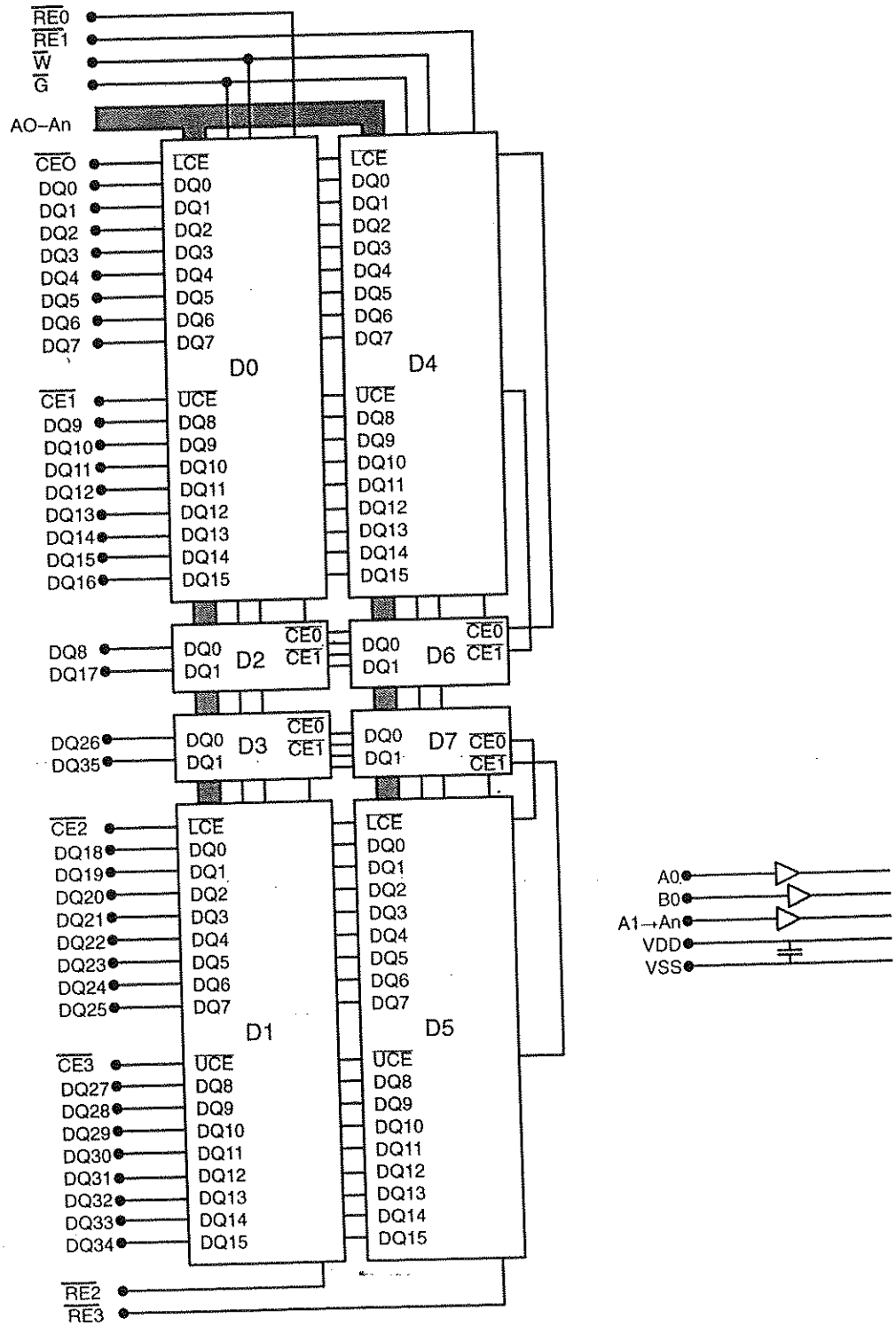



**FIGURE 4.4.2–2 G**

**X36 DRAM SIMM, 2 bank with X16 & X2 W/2 $\overline{CE}$ DRAMs**

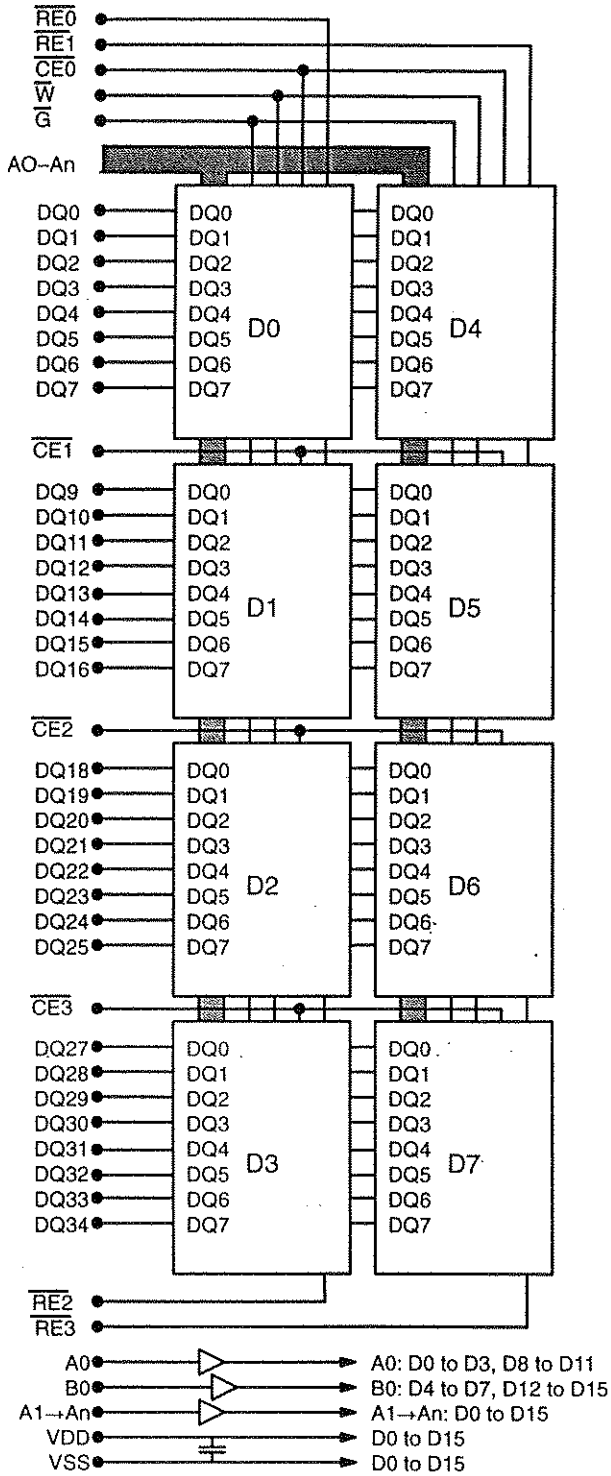



**FIGURE 4.4.2–2 H**
**X32 DRAM SIMM, 2 Banks with X8 DRAMs**

Release 6–7

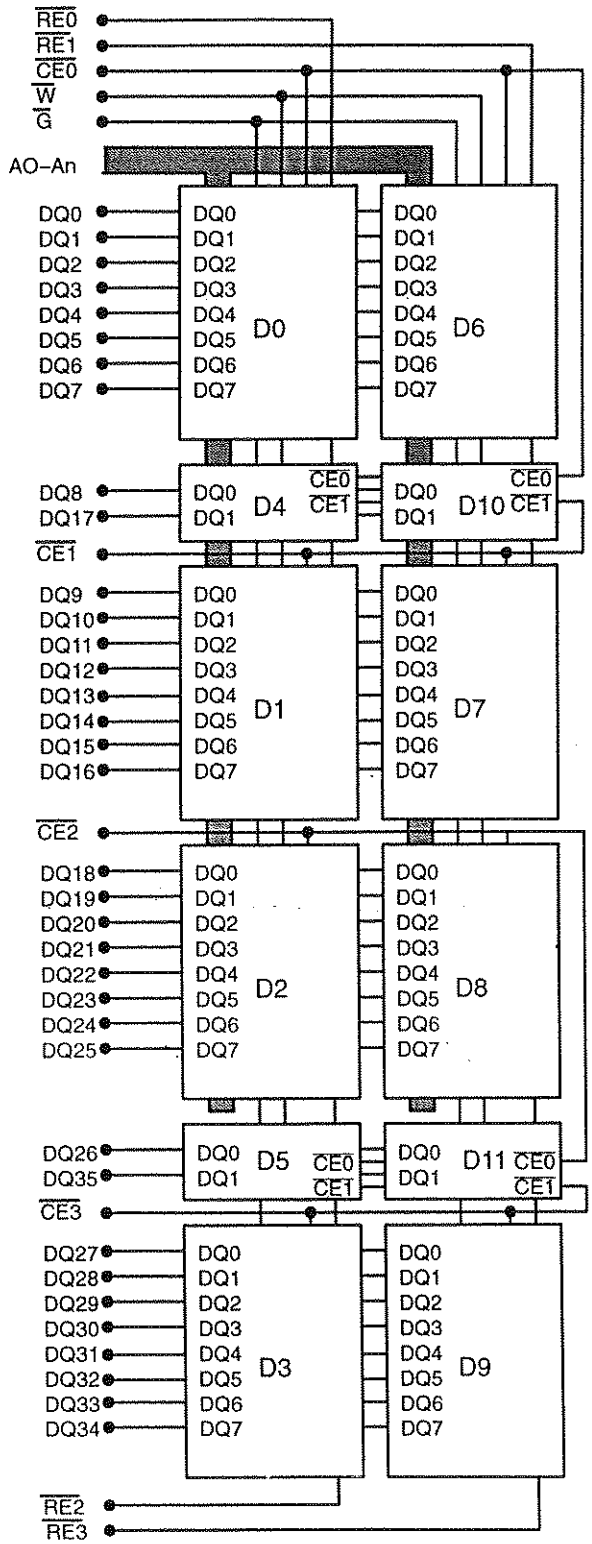



**FIGURE 4.4.2–2 I**
**X36 DRAM SIMM, 2 Banks with X8 & X2 W/2 $\overline{CE}$ DRAMs**

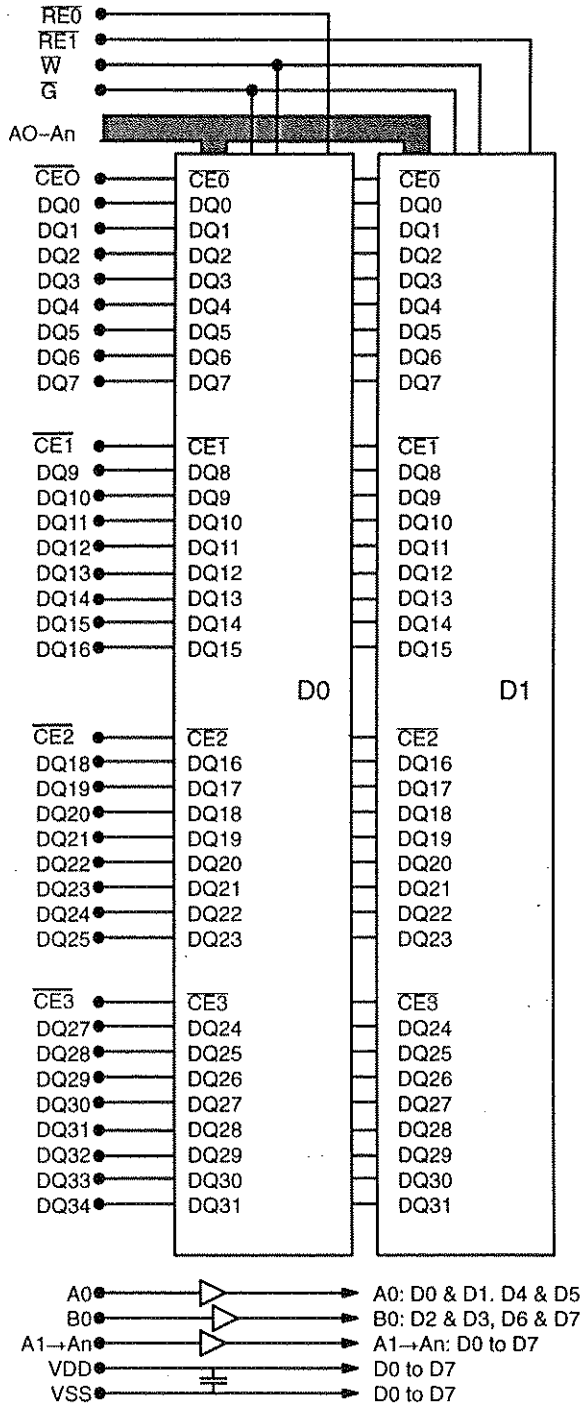



**FIGURE 4.4.2–2 J**
**X32 DRAM SIMM, 2 bank with X32 DRAMs**

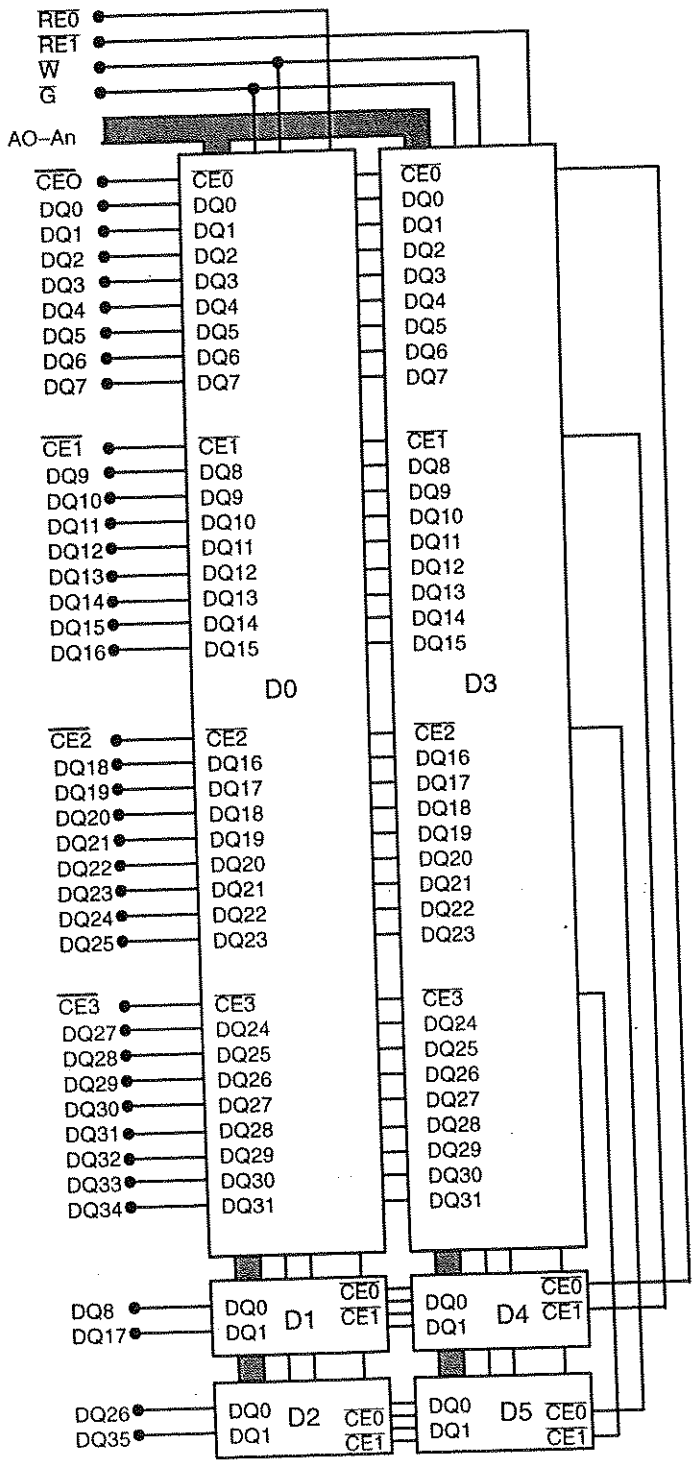



**FIGURE 4.4.2–2 K**

**X36 DRAM SIMM, 2 bank with X32 & X2 W/2 $\overline{CE}$ DRAMs**

| | 5 V ECC | 3.3 V ECC |
|---|---|---|
| PIN # | PIN NAME | PIN NAME |
| 1 | VSS | VSS |
| 2 | DQ0 | DQ0 |
| 3 | DQ1 | DQ1 |
| 4 | DQ2 | DQ2 |
| 5 | DQ3 | DQ3 |
| 6 | DQ4 | DQ4 |
| 7 | DQ5 | DQ5 |
| 8 | DQ6 | DQ6 |
| 9 | DQ7 | DQ7 |
| 10 | VDD | VDD |
| 11 | PD5 | PD5 |
| 12 | A0 | A0 |
| 13 | A1 | A1 |
| 14 | A2 | A2 |
| 15 | A3 | A3 |
| 16 | A4 | A4 |
| 17 | A5 | A5 |
| 18 | A6 | A6 |
| 19 | $\overline{G}$ | $\overline{G}$ |
| 20 | DQ8 | DQ8 |
| 21 | DQ9 | DQ9 |
| 22 | DQ10 | DQ10 |
| 23 | DQ11 | DQ11 |
| 24 | DQ12 | DQ12 |
| 25 | DQ13 | DQ13 |
| 26 | DQ14 | DQ14 |
| 27 | DQ15 | DQ15 |
| 28 | A7 | A7 |
| 29 | DQ16 | DQ16 |
| 30 | VDD | VDD |
| 31 | A8 | A8 |
| 32 | A9 | A9 |
| 33 | NC | NC, A12 |
| 34 | NC | NC, A13 |
| 35 | DQ17 | DQ17 |
| 36 | DQ18 | DQ18 |

| | 5 V ECC | 3.3 V ECC |
|---|---|---|
| PIN # | PIN NAME | PIN NAME |
| 37 | DQ19 | DQ19 |
| 38 | DQ20 | DQ20 |
| 39 | VSS | VSS |
| 40 | $\overline{CE0}$ | $\overline{CE0}$ |
| 41 | NC, A10 | A10 |
| 42 | NC, A11 | A11 |
| 43 | NC, $\overline{CE1}$ | $\overline{CE1}$ |
| 44 | $\overline{RE0}$ | $\overline{RE0}$ |
| 45 | NC, $\overline{RE1}$ | $\overline{RE1}$ |
| 46 | DQ21 | DQ21 |
| 47 | $\overline{W}$ | $\overline{W}$ |
| 48 | $\overline{ECC}$ | $\overline{ECC}$ |
| 49 | DQ22 | DQ22 |
| 50 | DQ23 | DQ23 |
| 51 | DQ24 | DQ24 |
| 52 | DQ25 | DQ25 |
| 53 | DQ26 | DQ26 |
| 54 | DQ27 | DQ27 |
| 55 | DQ28 | DQ28 |
| 56 | DQ29 | DQ29 |
| 57 | DQ30 | DQ30 |
| 58 | DQ31 | DQ31 |
| 59 | VDD | VDD |
| 60 | DQ32 | DQ32 |
| 61 | DQ33 | DQ33 |
| 62 | DQ34 | DQ34 |
| 63 | DQ35 | DQ35 |
| 64 | DQ36,NC | NC |
| 65 | DQ37,NC | NC |
| 66 | DQ38,NC | $\overline{EDO}$ |
| 67 | PD1 | PD1 |
| 68 | PD2 | PD2 |
| 69 | PD3 | PD3 |
| 70 | PD4 | PD4 |
| 71 | DQ39,NC | PD(REF) |
| 72 | VSS | VSS |

**PRESENCE DETECT TRUTH TABLE**

| TYPE | tRAC | $\overline{ECC}$ | PD1 | PD2 | PD3 | PD4 | #PD5 |
|---|---|---|---|---|---|---|---|
| 256K X 36 or 40 | 100 nS | S | S | O | S | S | O |
| 16M X 36/39 | 80 nS | S | S | O | O | S | O |
| | 70 nS | S | S | O | S | O | O |
| | 60 nS | S | S | O | O | O | O |
| 512K X 36 or 40 | 100 nS | S | O | S | S | S | O |
| 32M X 36/39 | 80 nS | S | O | S | O | S | O |
| | 70 nS | S | O | S | S | O | O |
| | 60 nS | S | O | S | O | O | O |
| 1M X 36 or 40 | 100 nS | S | S | S | S | S | O |
| 64M X 36/39 | 80 nS | S | S | S | O | S | O |
| | 70 nS | S | S | S | S | O | O |
| | 60 nS | S | S | S | O | O | O |
| 2M X 36 or 40 | 100 nS | S | O | O | S | S | O |
| 128M X 36/39 | 80 nS | S | O | O | O | S | O |
| | 70 nS | S | O | O | S | O | O |
| | 60 nS | S | O | O | O | O | O |
| 4M X 36 or 40 | 80 nS | S | S | O | O | S | S |
| 256M X 36/39 | 70 nS | S | S | O | S | O | S |
| | 60 nS | S | S | O | O | O | S |
| | 50 nS | S | S | O | S | S | S |
| 8M X 36 or 40 | 80 nS | S | O | S | O | S | S |
| 512M X 36/39 | 70 nS | S | O | S | S | O | S |
| | 60 nS | S | O | S | O | O | S |
| | 50 nS | S | O | S | S | S | S |

O = NC CONNECTION) S = CONNECTED TO VSS
$\overline{EDO}$ Pin: VSS FOR EDO, NC for Fast Page.
$\overline{ECC}$ Pin: VSS for ECC Module, OPEN for NON ECC Module
# The connection of PD5 to VSS must be made through a 2..6 KΩ resistor

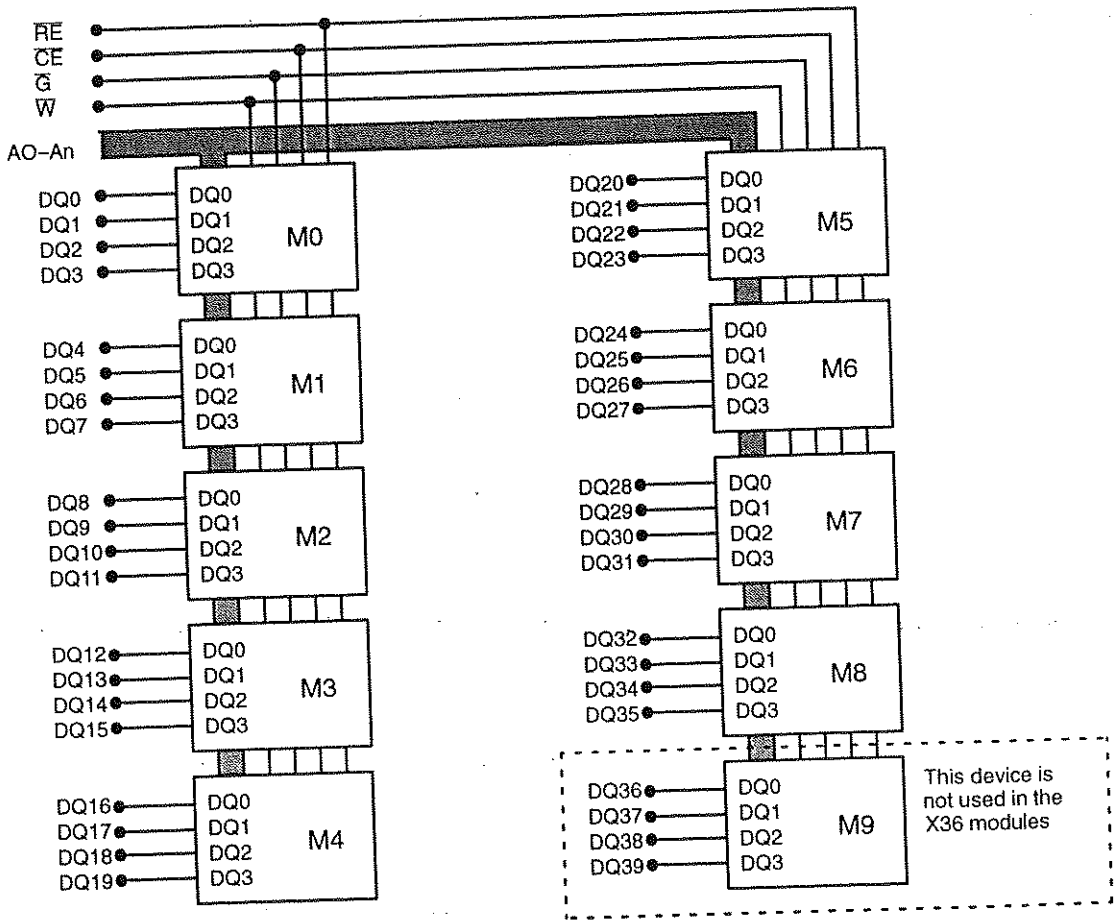
**CONFIGURATION PIN ASSIGNMENT TABLE**

| | MODULE SIZE, 36 or 39/40 BITS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PIN # | 256K | 512K | 1M | 2M | 4M | 8M | 16M | 32M | 64M | 128M | 256M | 512M |
| 19 | NC | NC | NC | NC | A10 | A10 | A10 | A10 | A10 | A10 | A10 | A10 |
| *29 | NC | NC | NC | NC | A11 | A11 | A11 | A11 | A11 | A11 | A11 | A11 |
| 32 | NC | NC | A9 | A9 | A9 | A9 | A9 | A9 | A9 | A9 | A9 | A9 |
| *33 | NC | $\overline{RE3}$ | NC | $\overline{RE3}$ | NC | $\overline{RE3}$ | A12 | A12 | A12 | A12 | A12 | A12 |
| *34 | NC | $\overline{RE2}$ | NC | $\overline{RE2}$ | NC | $\overline{RE2}$ | NC | NC | A13 | A13 | A13 | A13 |
| 45 | NC | $\overline{RE1}$ | NC | $\overline{RE1}$ | NC | $\overline{RE1}$ | NC | $\overline{RE1}$ | NC | $\overline{RE1}$ | NC | RE1 |

*A11, A12, or A13 on Pins 29, 33, or 34 are used on modules containing devices that require asymetric ROW/ COLUMN addresses.
NOTE – This family of pinouts is approved for use in SIMM modules which are nominally 4.25" long and with a height which varies depencing on the configuration and the memory devices used. See JEDEC Publication 95.




## FIGURE 4.4.2–3 A
## 256K TO 8M BY 36 or 40, 72 PIN ECC DRAM MODULE PINOUT




**BLOCK DIAGRAM for 256K/1M/4M X 36 or 40 USING X4 DRAM**

## FIGURE 4.4.2–3 B
## 36/40 BIT 72 PIN ECC DRAM SIMM, 1 Bank with X4 DRAMs

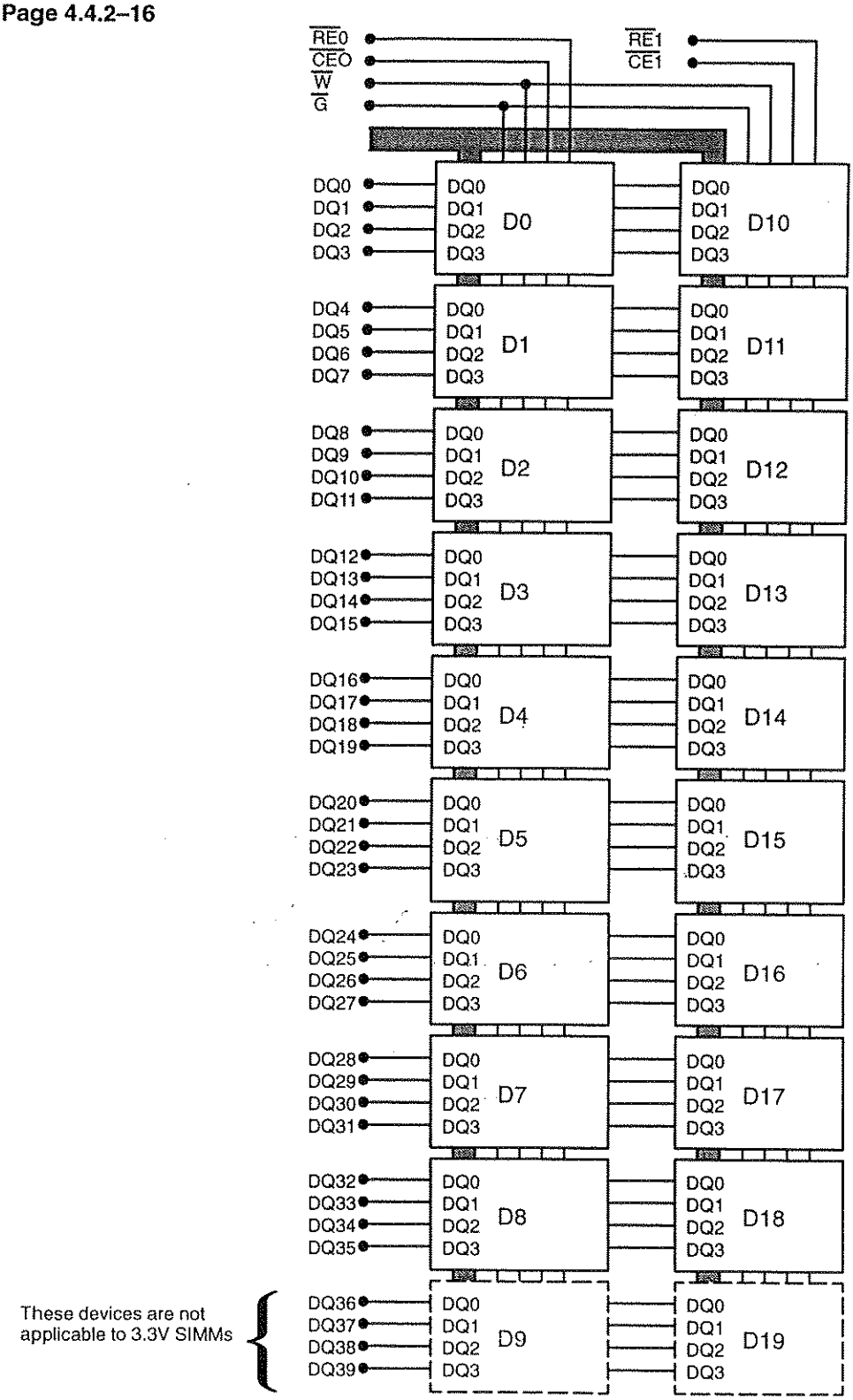


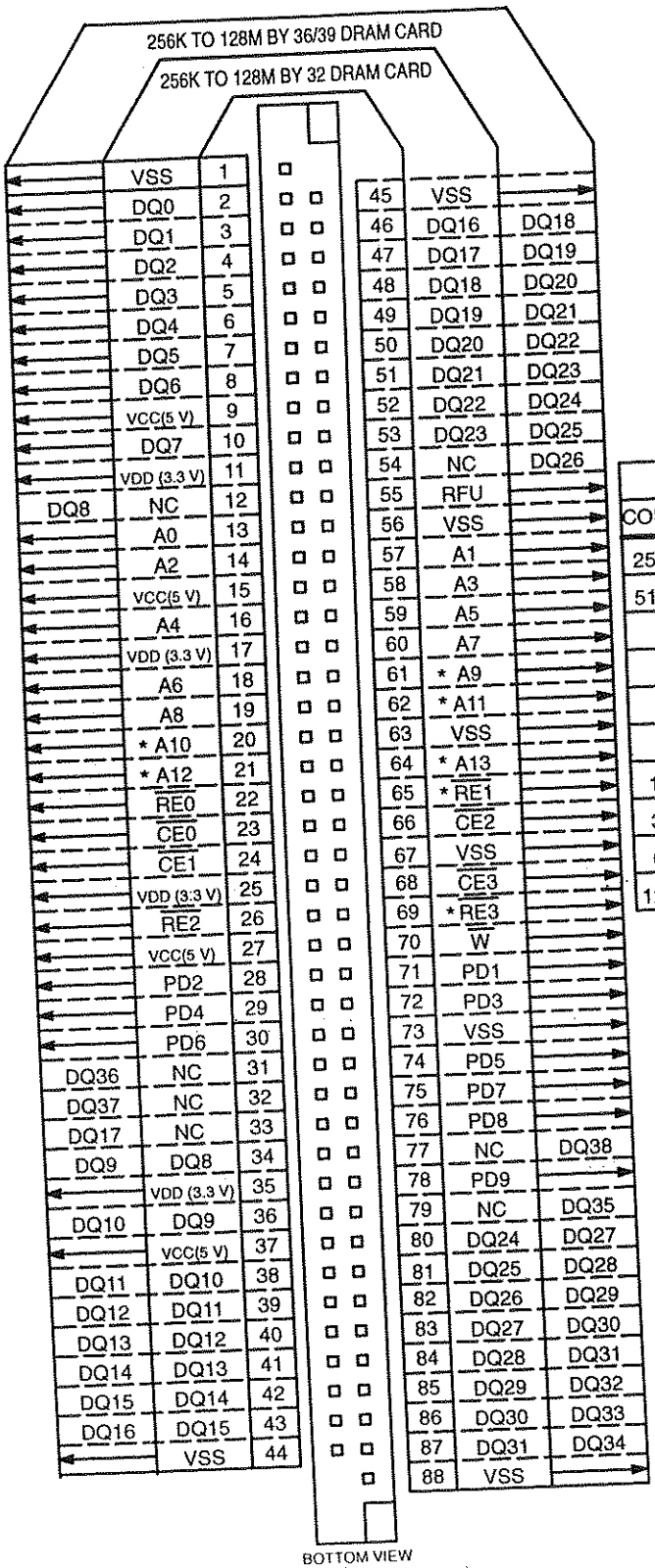

**FIGURE 4.4.2–3 C**
**36/40 BIT 72 PIN ECC DRAM SIMM, 2 Banks with X4 DRAMs**

## 4.4.3 – 88 PIN DRAM CARD FAMILIES

**NOTE:** There are two versions of this Card, shown in Figure 4.4.3–1 describing X 32 & 36/39 configurations, & 4.4.3–2 describing a X 40 configuration. They are similar but not fully compatible. Caution should be exercised in using these standards.

CAPACITY—256K TO 128M WORDS OF 32, 36, 39 OR 40 BITS
CONFIGURATION—16 Different Configurations Using 1mb, 4mb, 16mb, 64mb, & 256mb Devices
And With 2, Or 4 $\overline{\text{Re}}$ Clocks.
LOGIC FEATURES—The cards may be used with DATA BUS widths of X16/18 or X32/36 or X39— The cards contain a "PRESENCE DETECT" feature which conists of output pins which supply an encoded value which defines the storage capacity, configuration, and speed of the card.
PIN ASSIGNMENTS, 32, 36, & 39 bit—Fig. 4.4.3–1 A
PRESENCE DETECT TABLE 32, 36, & 39 bit—Fig. 4.4.3–1 B
CONFIGURATION BLOCK DIAGRAMS 32, 36, & 39 bit—Figs. 4.4.3–1 C, 4.4.3–1 D, 4.4.3–1 E, & 4.4.3–1 F
PIN ASSIGNMENTS, 40 bit—Fig. 4.4.3–2 A
PRESENCE DETECT TABLE 40 bit—Fig. 4.4.3–2 B
CONFIGURATION BLOCK DIAGRAMS 40 bit—Figs. 4.4.3–2 C, 4.4.3–2 D, 4.4.3–2 E, & 4.4.3–2 F
PACKAGE—88 PIN JEDEC MEMORY CARD

XILINX EXHIBIT 1012
Page 246




| | PD7 | PD6 |
|---|---|---|
| SPEED (tRAC) | 75 | 30 |
| 100 nS | VSS | VSS |
| 80 nS | VSS | NC |
| 70 nS | NC | VSS |
| 60 nS | NC | NC |
| 50 nS | VSS | VSS |

**PD SPEED TABLE**

| | PIN NUMBER | | | | | | |
|---|---|---|---|---|---|---|---|
| CONFIGURATION | 20 | 21 | 61 | 62 | 64 | 65 | 69 |
| 256K X 36, 2 $\overline{RE}$ | NC | NC | NC | NC | NC | NC | NC |
| 512K X 36, 4 $\overline{RE}$ | NC | NC | NC | NC | NC | RE1 | RE3 |
| 1M X 36, 2 $\overline{RE}$ | NC | NC | A9 | NC | NC | NC | NC |
| 2M X 36, 4 $\overline{RE}$ | NC | NC | A9 | NC | NC | RE1 | RE3 |
| 4M X 36, 2 $\overline{RE}$ | A10 | NC | A9 | A11 | NC | NC | NC |
| 8M X 36, 4 $\overline{RE}$ | A10 | NC | A9 | A11 | NC | RE1 | RE3 |
| 16M X 36, 2 $\overline{RE}$ | A10 | A12 | A9 | A11 | NC | NC | NC |
| 32M X 36, 4 $\overline{RE}$ | A10 | A12 | A9 | A11 | NC | RE1 | RE3 |
| 64M X 36, 2 $\overline{RE}$ | A10 | A12 | A9 | A11 | A13 | NC | NC |
| 128M X 36, 4 $\overline{RE}$ | A10 | A12 | A9 | A11 | A13 | RE1 | RE3 |

**ADDRESS AND CLOCK PIN ASSIGNMENTS**

| Data Access Mode | PD9 |
|---|---|
| FAST PAGE | NC |
| EDO | VSS |

* SEE TABLE FOR FUNCTION ASSIGNMENTS FOR THESE PINS AS A FUNCTION OF CARD CAPACITY AND CONFIGURATION

**FIGURE 4.4.3–1 A**
**88 PIN, BY 32 and 36/39 DRAM CARD PINOUT**

| PD BITS 5 4 3 2 1 | CARD DENSITY | DRAM ORGANIZATION | CARD ADDR. REQ'D | RE ADDR. | CE ADDR. | AVAIL. PAGE DEPTH | AVERAGE REFRESH INTERVAL | NOTES |
|---|---|---|---|---|---|---|---|---|
| 1 1 1 1 1 | NO CARD | | | | | | | NO CARD INSTALLED |
| 1 0 0 0 0 | 1 MB | 256K X 1, 4, 16, 18 | 18 | 9 | 9 | 512 | 125 mS | |
| 0 0 0 0 0 | 2 MB | 256K X 1, 4, 16, 18 | 18 | 9 | 9 | 512 | 125 mS | |
| 1 0 0 0 1 | 2 MB | 512K X 8, 9 | 19 | 10 | 9 | 512 | 125 mS | |
| 0 0 0 0 1 | 4 MB | 512K X 8, 9 | 19 | 10 | 9 | 512 | 125 mS | |
| 1 0 0 1 0 | 4 MB | 1M X 1, 4, 16, 18 | 20 | 10 | 10 | 1024 | 125 mS | |
| 0 0 0 1 0 | 8 MB | 1M X 1, 4, 16, 18 | 20 | 10 | 10 | 1024 | 125 mS | |
| 1 1 0 1 0 | 4 MB | 1M X 16, 18 | 20 | 12 | 8 | 256 | 62 mS | |
| 0 1 0 1 0 | 8 MB | 1M X 16, 18 | 20 | 12 | 8 | 256 | 62 mS | |
| 1 0 0 1 1 | 8 MB | 2M X 8, 9 | 21 | 11 | 10 | 1024 | 125 mS | |
| 0 0 0 1 1 | 16 MB | 2M X 8, 9 | 21 | 11 | 10 | 1024 | 125 mS | |
| 1 0 1 0 0 | 16 MB | 4M X 1, 4, 16, 18 | 22 | 12 | *11 | **1024 | 62 mS | SUPPORT 12/10 AND 11/11 ADDRESS |
| 0 0 1 0 0 | 32 MB | 4M X 1, 4, 16, 18 | 22 | 12 | *11 | **1024 | 62 mS | SUPPORT 12/10 AND 11/11 ADDRESS |
| 1 0 1 0 1 | 32 MB | 8M X 8, 9 | 23 | 13 | *11 | **1024 | 62 mS | SUPPORT 13/10 AND 12/11 ADDRESS |
| 0 0 1 0 1 | 64 MB | 8M X 8, 9 | 23 | 13 | *11 | **1024 | 62 mS | SUPPORT 13/10 AND 12/11 ADDRESS |
| 1 0 1 1 0 | 64 MB | 16M X 1, 4, 16, 18 | 24 | 14 | *11 | **1024 | 31 mS | SUPPORT 13/11 AND 14/10 ADDRESS |
| 0 0 1 1 0 | 128MB | 16M X 1, 4, 16, 18 | 24 | 14 | *11 | **1024 | 31 mS | SUPPORT 13/11 AND 14/10 ADDRESS |

* INDICATES REDUNDANT ADDRESS THAT MUST BE PROVIDED AT CE\ TIME (TO ALLOW USE OF MIXED DRAM ADDRESSING)
** PAGE DEPTH DETERMINED BY THE SMALLEST CE\ ADDRESS DRAM
*** ALL DENSITIES ASSUME 4 BYTE CARD DATA WIDTH (32 OR 36 BITS)
FOR THE PDn PINS, 1 = NC, 0 = VSS

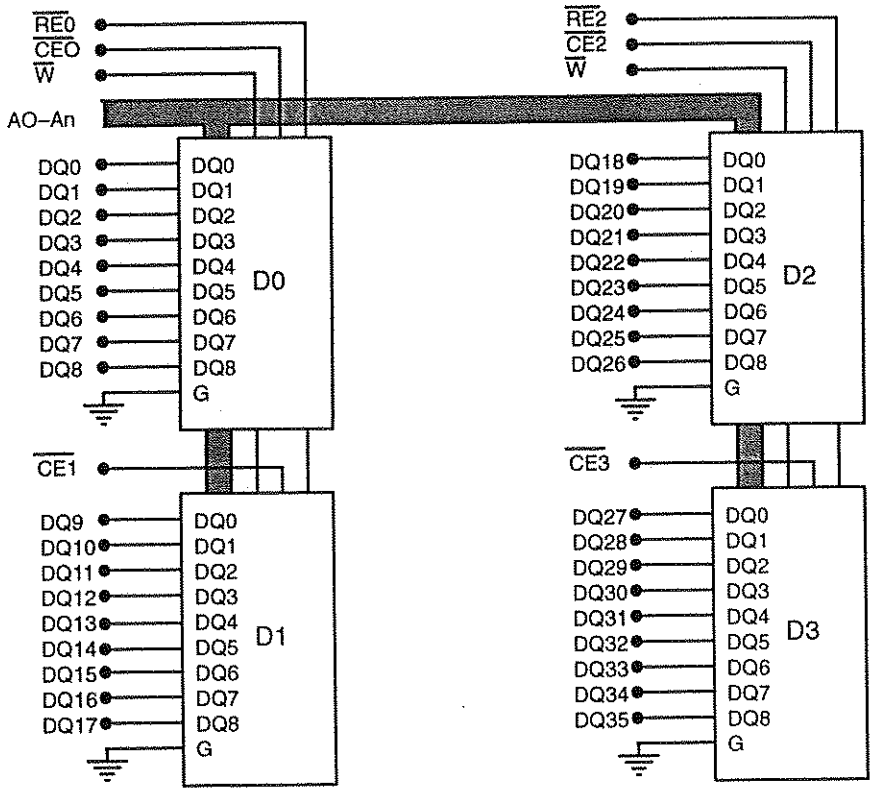
**MEMORY CARD ORGANIZATION AND ADDRESS STRUCTURE**

| BASE DEVICE | CONFIG'N | PIN NUMBER 9 | 11 | 15 | 17 | 25 | 27 | 35 | 37 |
|---|---|---|---|---|---|---|---|---|---|
| 1M | 256K X 36, 2 $\overline{RE}$ | 5 V | NC | 5 V | NC | NC | 5 V | NC | 5 V |
| 1M | 512K X 36, 4 $\overline{RE}$ | 5 V | NC | 5 V | NC | NC | 5 V | NC | 5 V |
| 4M | 1M X 36, 2 $\overline{RE}$ | 5 V,NC | NC, 3.3 V | 5 V, NC | NC, 3.3 V | NC, 3.3 V | 5 V, NC | NC, 3.3 V | 5 V, NC |
| 4M | 2M X 36, 4 $\overline{RE}$ | 5 V, NC | NC, 3.3 V | 5 V, NC | NC, 3.3 V | NC, 3.3 V | 5 V, NC | NC, 3.3 V | 5 V, NC |
| 16M | 4M X 36, 2 $\overline{RE}$ | 5 V, NC | NC, 3.3 V | 5 V, NC | NC, 3.3 V | NC, 3.3 V | 5 V, NC | NC, 3.3 V | 5 V, NC |
| 16M | 8M X 36, 4 $\overline{RE}$ | 5 V, NC | NC, 3.3 V | 5 V, NC | NC, 3.3 V | NC, 3.3 V | 5 V, NC | NC, 3.3 V | 5 V, NC |
| 64M | 16M X 36, 2 $\overline{RE}$ | NC | 3.3 V | NC | 3.3 V | 3.3 V | NC | 3.3 V | NC |
| 64M | 32M X 36, 4 $\overline{RE}$ | NC | 3.3 V | NC | 3.3 V | 3.3 V | NC | 3.3 V | NC |
| 256M | 64M X 36, 2 $\overline{RE}$ | NC | 3.3 V | NC | 3.3 V | 3.3 V | NC | 3.3 V | NC |
| 256M | 128M X 36, 4 $\overline{RE}$ | NC | 3.3 V | NC | 3.3 V | 3.3 V | NC | 3.3 V | NC |

**VDD POWER PIN ASSIGNMENT TABLE**

## FIGURE 4.4.3–1 B
## 88 PIN, BY 32 AND 36/39 DRAM CARD CONFIGURATION TABLES

**BLOCK DIAGRAM for 512K /2M/8M/32M X 36 or 1M/4M/16M/64M X 18 USING X8 or X9 DRAM**



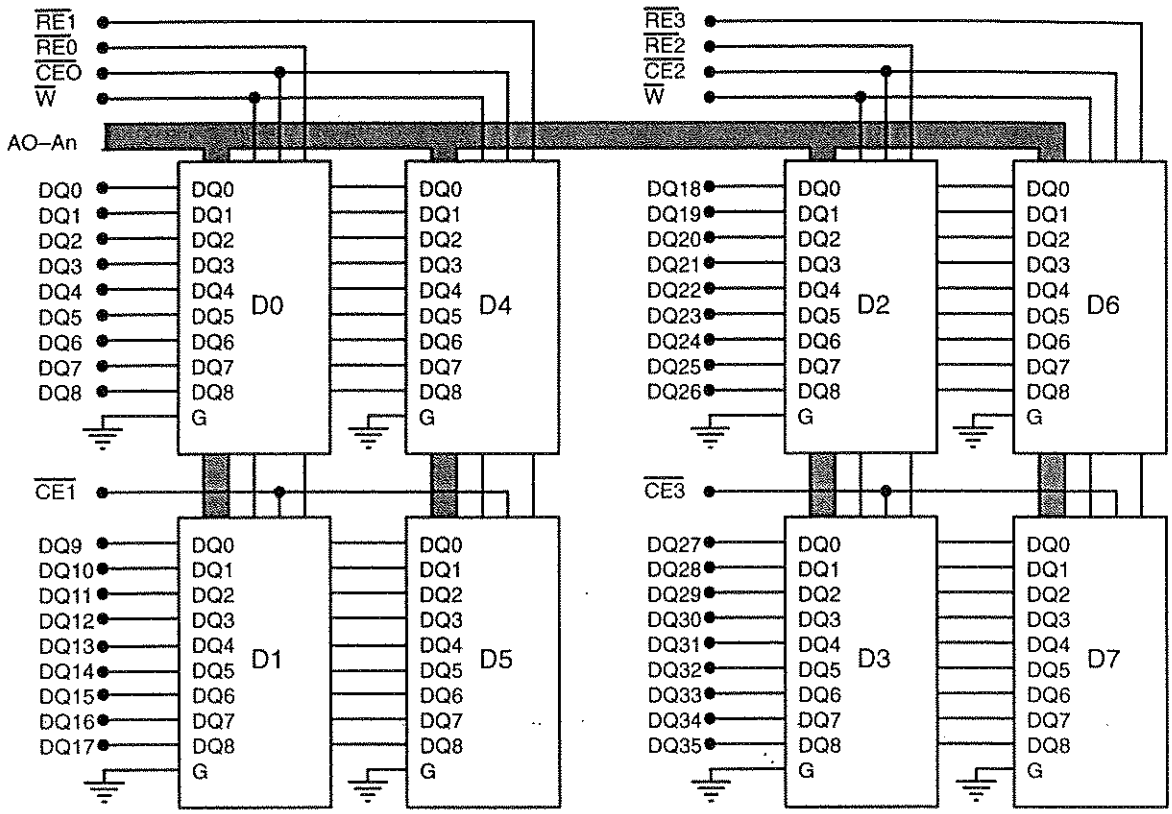

| WORD ORGANIZATION | * BASE MEMORY DEVICE | |
|---|---|---|
| | D0 – D3 | ADDRESS |
| 512K X 36 or 1M X 18 | 4M (X9) | A0 – A9 |
| 2M X 36 or 4M X 18 | 16M (X9) | A0 – A10 |
| 8M X 36 or 16M X 18 | 64M (X9) | A0 – A12 |

* NOTE: The BASE MEMORY DEVICE columns give the total device capacity in bits and the data interface configuration

note 1: In an 18 bus system, $\overline{RE0}$ and $\overline{RE2}$ will be controlled independently and the data bus will be connected to for an 18 bit bus ourside the card
In a 36 bit system, $\overline{RE0}$ and $\overline{RE2}$ will be actuated simultaneously
note 2: The card contains 4 bytes of data; 2 byte operation is allowed.

## FIGURE 4.4.3–1 C
## 88 PIN, BY 36, DRAM CARD 1 BANK USING BY 9 DEVICES

**BLOCK DIAGRAM for 1M /4M/16M/64M X 36 or 2M/8M/32M/128M X 18 USING X8 or X9 DRAM**



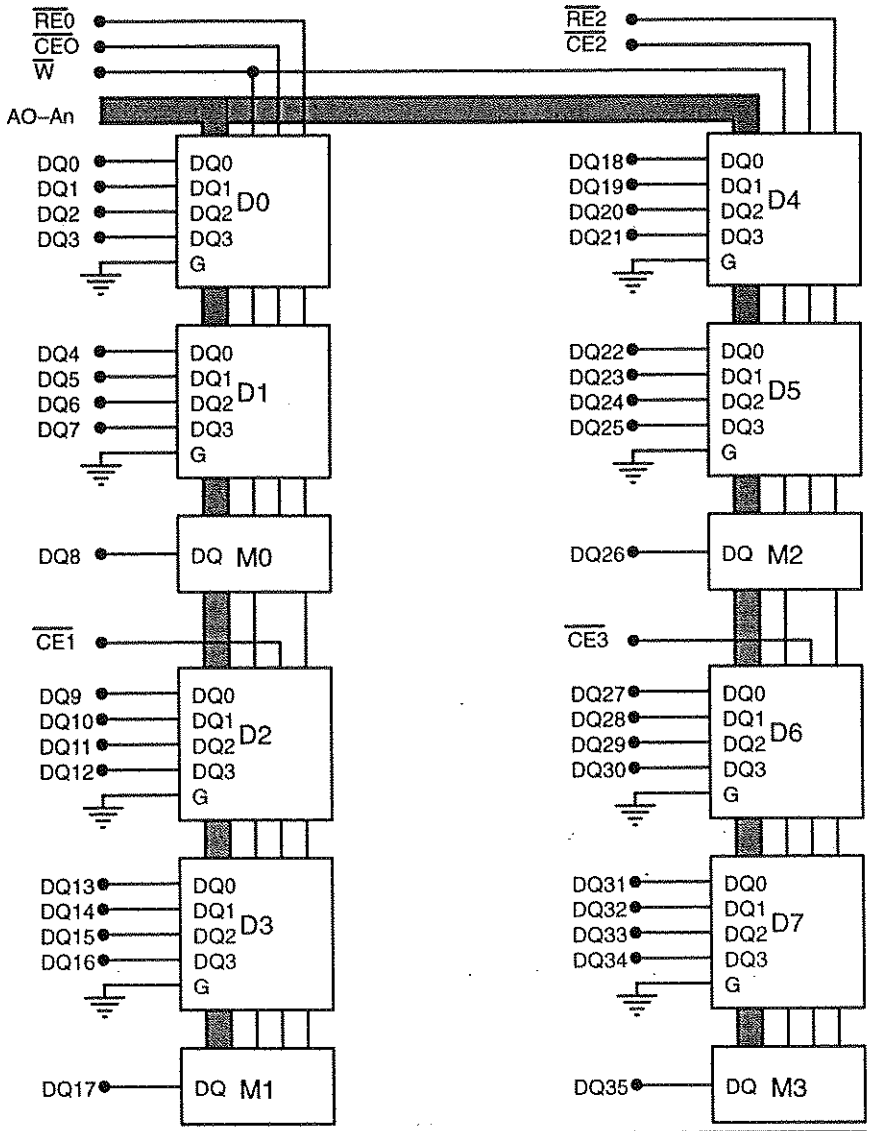

| WORD ORGANIZATION | * BASE MEMORY DEVICE | |
|---|---|---|
| | D0 – D7 | ADDRESS |
| 1M X 36 or 2M X 18 | 4M (X9) | A0 – A9 |
| 4M X 36 or 8M X 18 | 16M (X9) | A0 – A10 |
| 16M X 36 or 32M X 18 | 64M (X9) | A0 – A12 |

* NOTE: The BASE MEMORY DEVICE columns give the total device capacity in bits and the data interface configuration

note 1: In an 18 bus system, $\overline{RE0}$ and $\overline{RE2}$ (also $\overline{RE1}$ and $\overline{RE3}$) will be controlled independently and the data bus will be connected to for an 18 bit bus ourside the card
In a 36 bit system, $\overline{RE0}$ and $\overline{RE2}$ (also $\overline{RE1}$ and $\overline{RE3}$) will be actuated simultaneously
note 2: The card contains 4 bytes of data; 2 byte operation is allowed.

## FIGURE 4.4.3–1 D
## 88 PIN, BY 36, DRAM CARD 2 BANK USING BY 9 DEVICES

**BLOCK DIAGRAM for 256K /1M/4M/16M/64M X 36 or 512K/2M/8M/32M/128M X 18 USING X4 and X1 DRAM**




| WORD ORGANIZATION | * BASE MEMORY DEVICE | | |
|---|---|---|---|
| | D0 – D7 | M0 – M3 | ADDRESS |
| 256K X 36 or 512K X 18 | 1M (X4) | 256K (X1) | A0 – A8 |
| 1M X 36 or 2M X 18 | 4M (X4) | 1M (X1) | A0 – A9 |
| 4M X 36 or 8M X 18 | 16M (X4) | 4M (X1) | A0 – A11 |
| 16M X 36 or 32M X 18 | 64M (X4) | 16M (X1) | A0 – A13 |

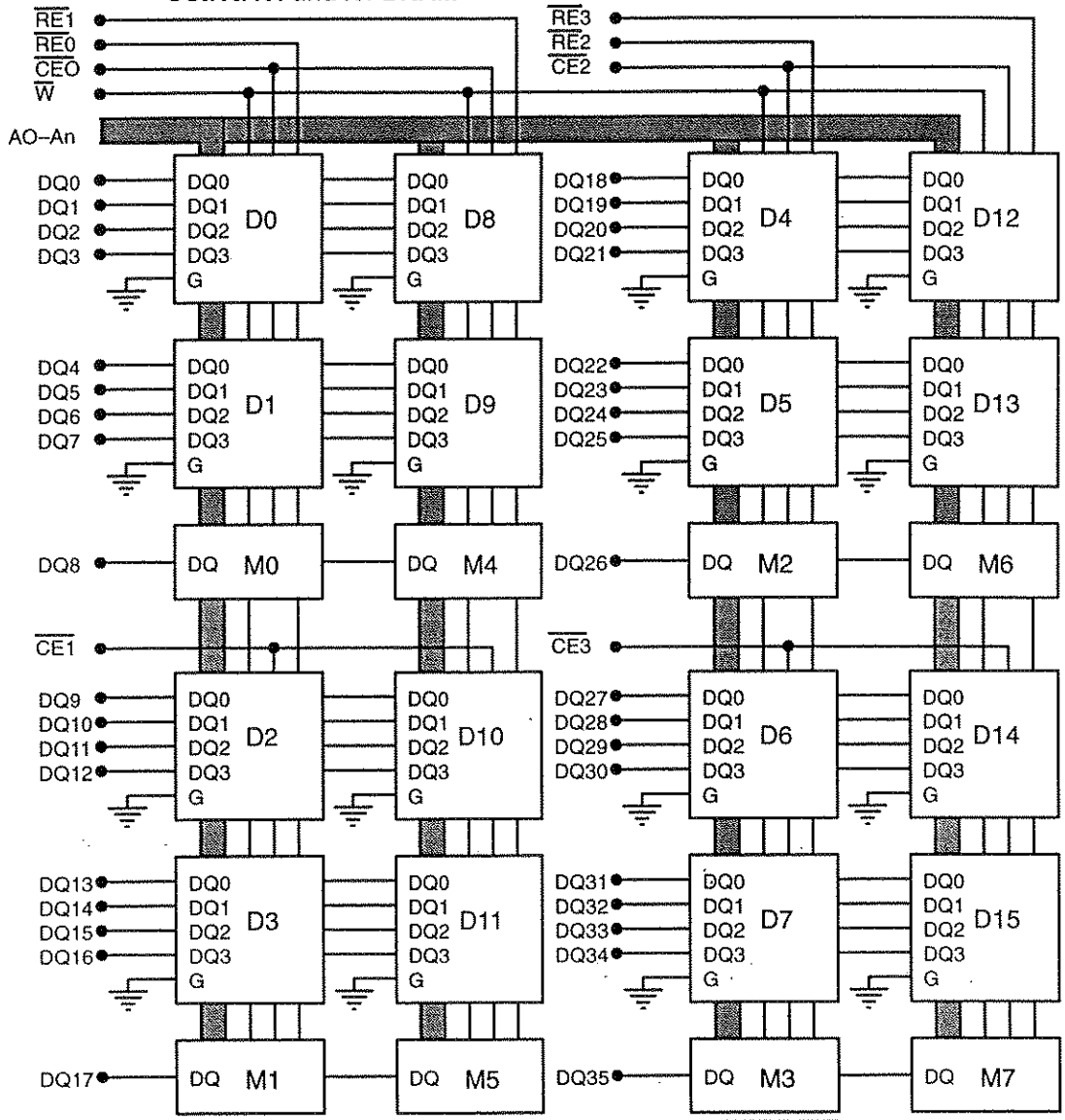
* NOTE: The BASE MEMORY DEVICE columns give the total device capacity in bits and the data interface configuration

note 1: In an 18 bus system, $\overline{RE0}$ and $\overline{RE2}$ will be controlled independently and the data bus will be connected to for an 18 bit bus ourside the card
In a 36 bit system, $\overline{RE0}$ and $\overline{RE2}$ will be actuated simultaneously

note 2: The card contains 4 bytes of data; 2 byte operation is allowed.

## FIGURE 4.4.3–1 E
## 88 PIN, 36, DRAM CARD 1 BANK USING BY 4 & BY 1 DEVICES

**BLOCK DIAGRAM for 512K/2M/8M/32M/32M/128M X 36 or 1M/4M/16M/256M X 18 USING X4 and X1 DRAM**




| WORD ORGANIZATION | * BASE MEMORY DEVICE | | |
|---|---|---|---|
| | D0 – D15 | M0 – M7 | ADDRESS |
| 512K X 36 or 1M X 18 | 1M (X4) | 256K(X1) | A0 – A8 |
| 2M X 36 or 4M X 18 | 4M (X4) | 1M (X1) | A0 – A9 |
| 8M X 36 or 16M X 18 | 16M (X4) | 4M (X1) | A0 – A11 |
| 32M X 36 or 64M X 18 | 64M (X4) | 16M (X1) | A0 – A13 |

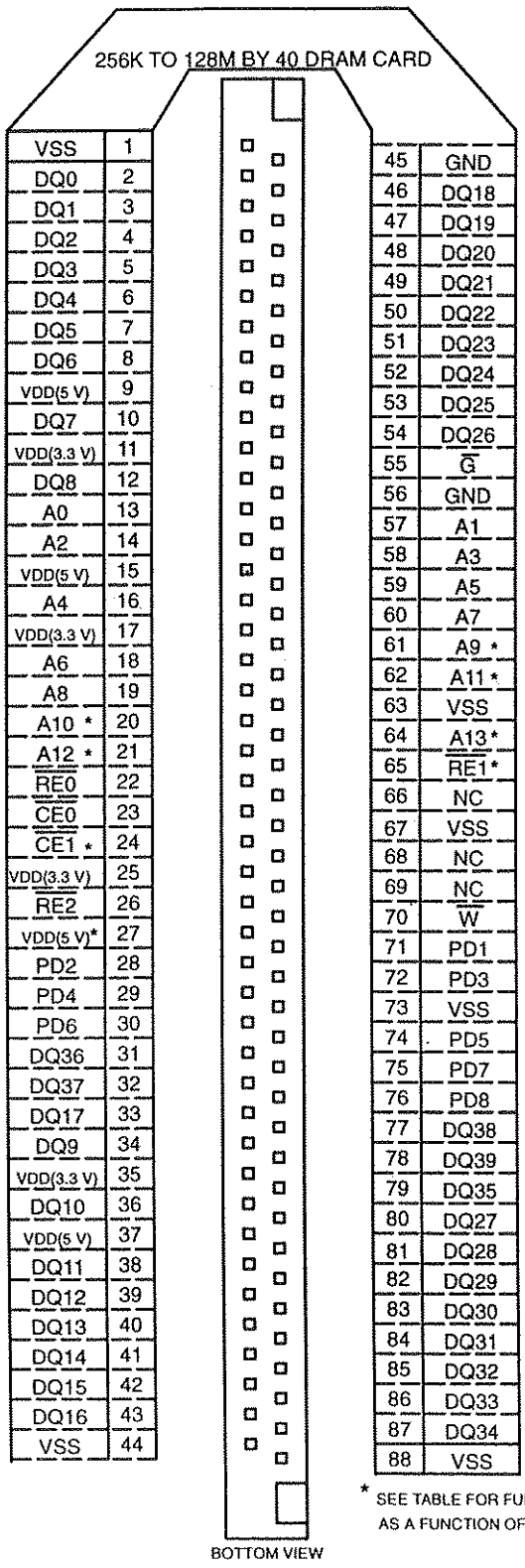
* NOTE: The BASE MEMORY DEVICE columns give the total device capacity in bits and the data interface configuration

note 1: In an 18 bus system, $\overline{RE0}$ and $\overline{RE2}$ (also $\overline{RE1}$ AND $\overline{RE3}$) will be controlled independently and the data bus will be connected to for an 18 bit bus ourside the card,
In a 36 bit system, $\overline{RE0}$ and $\overline{RE2}$ (also $\overline{RE1}$ and $\overline{RE3}$) will be actuated simultaneously

note 2: The card contains 4 bytes of data; 2 byte operation is allowed.

## FIGURE 4.4.3–1 F

## 88 PIN, BY 36 DRAM CARD 2 BANK USING BY 4 & BY 1 DEVICES




* SEE TABLE FOR FUNCTIONAL ASSIGNMENTS FOR THESE PINS AS A FUNCTION OF CARD CAPACITY AND CONFIGURATION

| Pin Assignment, Cards based on X4 DRAM | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Card Pin Number | | | | | | | |
| CONFIGURATION | 20 | 21 | 24 | 27 | 61 | 62 | 64 | 65 |
| 256K X 40 (1M) | NC | NC | NC | 5 V, NC | NC | NC | NC | NC |
| 512K X 40 (1M) | NC | NC | $\overline{CE1}$ | 5 V, NC | NC | NC | NC | $\overline{RE1}$ |
| 1M X 40 (4M) | NC | NC | NC | 5 V, NC | A9 | NC | NC | NC |
| 2M X 40 (4M) | NC | NC | $\overline{CE1}$ | 5 V, NC | A9 | NC | NC | $\overline{RE1}$ |
| 4M X 40 (16M) | A10 | NC | NC | 5 V, NC | A9 | A11 | NC | NC |
| 8M X 40 (16M) | A10 | NC | $\overline{CE1}$ | 5 V, NC | A9 | A11 | NC | $\overline{RE1}$ |
| 16M X 40 (64M) | A10 | A12 | NC | NC | A9 | A11 | NC | NC |
| 32M X 40 (64M) | A10 | A12 | $\overline{CE1}$ | NC | A9 | A11 | NC | $\overline{RE1}$ |
| 64M X 40 (256M) | A10 | A12 | NC | NC | A9 | A11 | A13 | NC |
| 128M X 40 (256M) | A10 | A12 | $\overline{CE1}$ | NC | A9 | A11 | A13 | $\overline{RE1}$ |

| Pin Assignment, Cards based on X8 DRAM | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Card Pin Number | | | | | | | |
| CONFIGURATION | 20 | 21 | 24 | 27 | 61 | 62 | 64 | 65 |
| 512K X 40 (4M) | NC | NC | NC | 5 V, NC | A9 | NC | NC | NC |
| 1M X 40 (4M) | NC | NC | $\overline{CE1}$ | 5 V, NC | A9 | NC | NC | $\overline{RE1}$ |
| 2M X 40 (16M) | A10 | NC | NC | 5 V, NC | A9 | A11 | NC | NC |
| 4M X 40 (16M) | A10 | NC | $\overline{CE1}$ | 5 V, NC | A9 | A11 | NC | $\overline{RE1}$ |
| 8M X 40 (64M) | A10 | A12 | NC | NC | A9 | A11 | NC | NC |
| 16M X 40 (64M) | A10 | A12 | $\overline{CE1}$ | NC | A9 | A11 | NC | $\overline{RE1}$ |
| 32M X 40 (256M) | A10 | A12 | NC | NC | A9 | A11 | A13 | NC |
| 64M X 40 (256M) | A10 | A12 | $\overline{CE1}$ | NC | A9 | A11 | A13 | $\overline{RE1}$ |

**ADDRESS AND CLOCK PIN ASSIGNMENTS**

# FIGURE 4.4.3–2 A
# 88 PIN, BY 40 DRAM CARD

| | PD7 | PD6 |
|---|---|---|
| SPEED (tRAC) | P 75 | P 30 |
| 80 nS | VSS | NC |
| 70 nS | NC | VSS |
| 60 nS | NC | NC |
| 50 nS | VSS | VSS |

**PD SPEED TABLE**

| | PD8 |
|---|---|
| REFRESH MODE | P 76 |
| 80 nS | VSS |
| 70 nS | NC |

**PD REFRESH MODE TABLE**

| PD BITS 5 4 3 2 1 | CARD DENSITY | DRAM ORGANIZATION | RE ADDR. | CE ADDR. | REFRESH PERIOD (mS) NORMAL | SLOW |
|---|---|---|---|---|---|---|
| 1 1 1 1 1 | NO CARD | | | | | |
| 1 0 0 0 0 | 1 MB | 256K X 4 | 9 | 9 | 8 | 64 |
| 0 0 0 0 0 | 2 MB | 256K X 4 | 9 | 9 | 8 | 64 |
| 1 0 0 0 1 | 2 MB | 512K X 8 | 10 | 9 | 16 | 128 |
| 0 0 0 0 1 | 4 MB | 512K X 8 | 10 | 9 | 16 | 128 |
| 1 0 0 1 0 | 4 MB | 1M X 4 | 10 | 10 | 16 | 128 |
| 0 0 0 1 0 | 8 MB | 1M X 4 | 10 | 10 | 16 | 128 |
| 1 0 0 1 1 | 8 MB | 2M X 8 | 11 | 10 | 32 | 256 |
| 0 0 0 1 1 | 16 MB | 2M X 8 | 11 | 10 | 32 | 256 |
| 1 0 1 0 0 | 16 MB | 4M X 4 | 11/12 | 11/10 | 64 | 256 |
| 0 0 1 0 0 | 32 MB | 4M X 4 | 11/12 | 11/10 | 64 | 256 |
| 1 0 1 0 1 | 32 MB | 8M X 8 | 12/13 | 11/10 | TBD | TBD |
| 0 0 1 0 1 | 64 MB | 8M X 8 | 12/13 | 11/10 | TBD | TBD |
| 1 0 1 1 0 | 64 MB | 16M X 4 | 13 | 11 | TBD | TBD |
| 0 0 1 1 0 | 128 MB | 16M X 4 | 13 | 11 | TBD | TBD |
| 1 0 1 0 1 | 128 MB | 32M X 8 | TBD | TBD | TBD | TBD |
| 0 0 1 0 1 | 256 MB | 32M X 8 | TBD | TBD | TBD | TBD |
| 1 0 1 1 0 | 256 MB | 64M X 4 | TBD | TBD | TBD | TBD |
| 0 0 1 1 0 | 512 MB | 64M X 4 | TBD | TBD | TBD | TBD |

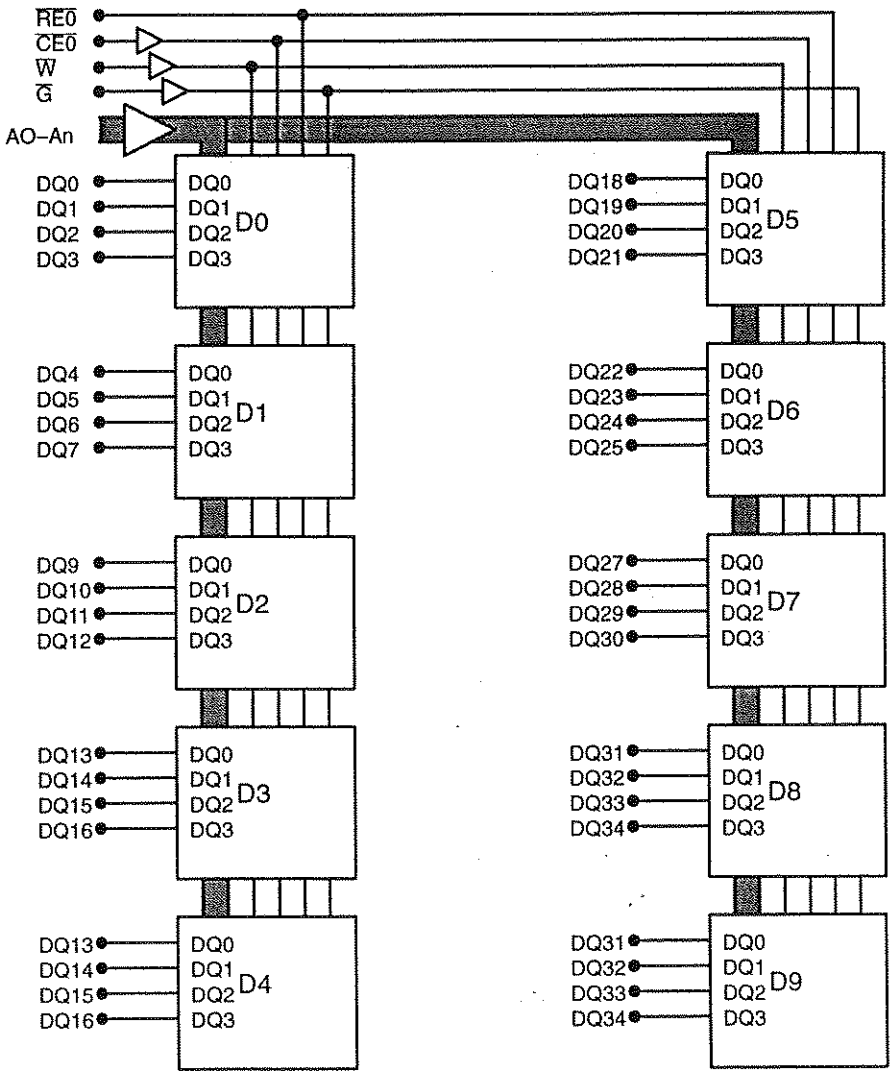
FOR THE PDn PINS, 1 = NC, 0 = VSS
NOTE: In the above address table, optional address configurations are given for some devices to allow for different approved refresh counts.

**MEMORY CARD ORGANIZATION AND ADDRESS STRUCTURE**

NOTE: The DRAM densities are shown in parentheses (xxxM)

## FIGURE 4.4.3–2 B
## 88 PIN, BY 40 DRAM CARD PD TRUTH TABLE

**BLOCK DIAGRAM for 256K/1M/4M/16M/64M X 40 USING X4 DRAM**



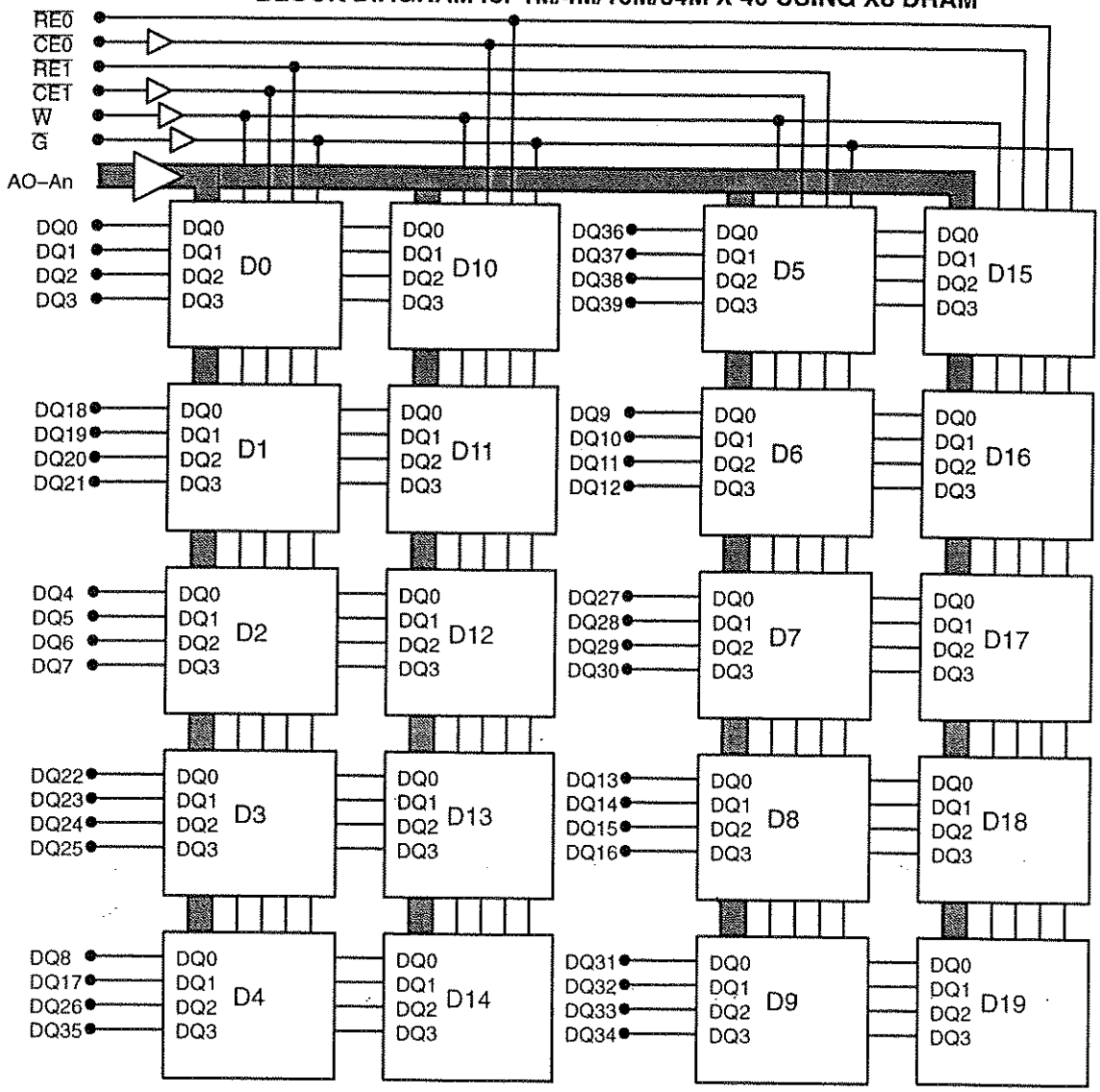

| WORD ORGANIZATION | *Base Memory Device D0 to D9 | ADDRESS FIELD | OPTIONAL ADDRESS |
|---|---|---|---|
| 256K X 40 | 1M (X4) | A0 – A8 | NA |
| 1M X 40 | 4M (X8) | A0 – A9 | NA |
| 4M X 40 | 16M (X8) | A0 – A10 | A0–A11 |
| 16M X 40 | 64M (X8) | A0 – A11 | A0–A12 |
| 64M X 40 | 256M (X8) | TBD | TBD |

* NOTE: The BASE MEMORY DEVICE columns give the total device capacity in bits and the data interface word width.

NOTE: There shall be one bypass capacitor between VDD and VSS fore each memory device on the card.

## FIGURE 4.4.3–2 C
## 88 PIN, BY 40 DRAM CARD 1 BANK USING BY 4 DEVICES

**BLOCK DIAGRAM for 1M/4M/16M/64M X 40 USING X8 DRAM**



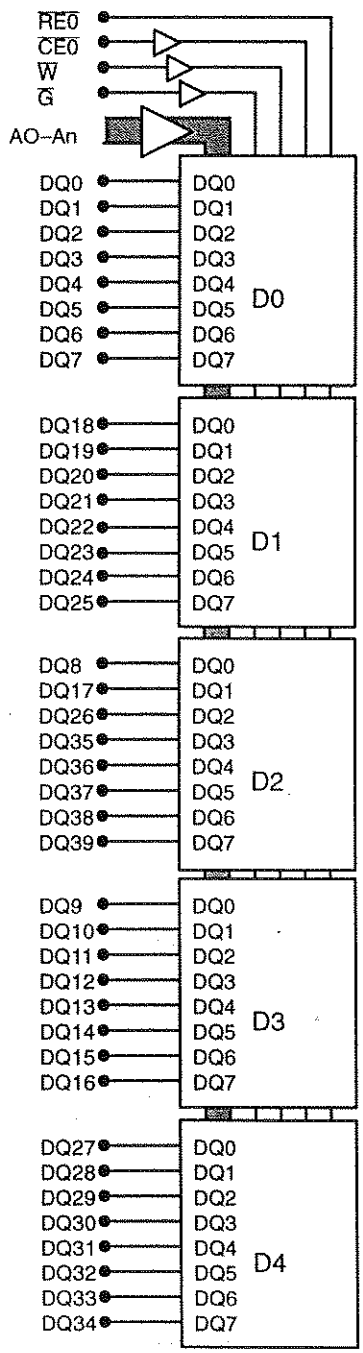

| WORD ORGANIZATION | *Base Memory Device D0 to D19 | ADDRESS FIELD | OPTIONAL ADDRESS |
|---|---|---|---|
| 512K X 40 | 1M (X4) | A0 – A8 | NA |
| 2M X 40 | 4M (X8) | A0 – A9 | NA |
| 8M X 40 | 16M (X8) | A0 – A10 | A0–A11 |
| 32M X 40 | 64M (X8) | A0 – A11 | A0–A12 |
| 128M X 40 | 256M (X8) | TBD | TBD |

* NOTE: The BASE MEMORY DEVICE columns give the total device capacity in bits and the data interface word width.

NOTE: There shall be one bypass capacitor between VDD and VSS fore each pair of memory devices on the card. The value of the capacitors will be determined by the memory devices used.

## FIGURE 4.4.3–2 D
## 88 PIN, BY 40 DRAM CARD 2 BANK USING BY 4 DEVICES

**BLOCK DIAGRAM for 512K/2M/8M/32M X 40 USING X8 DRAM**



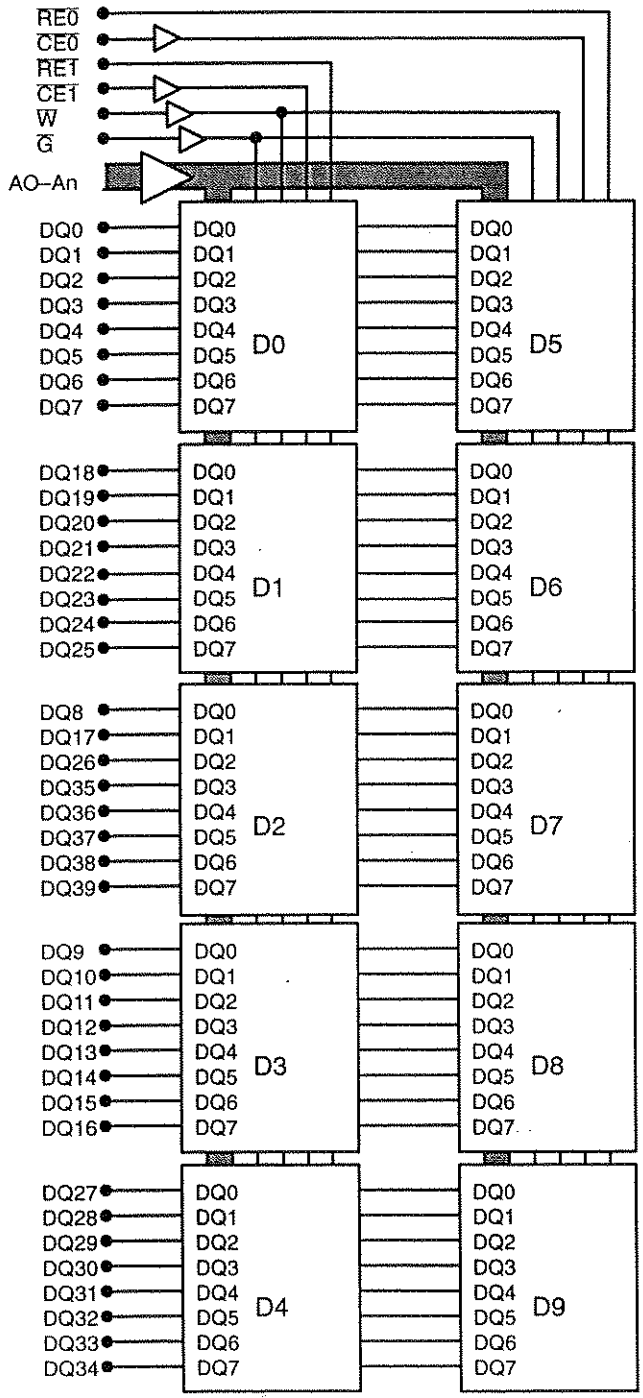

| WORD ORGANIZATION | *Base Memory Device D0 to D4 | ADDRESS FIELD |
|---|---|---|
| 512K X 40 | 4M (X8) | A0 – A9 |
| 2M X 40 | 16M (X8) | A0 – A10 |
| 8M X 40 | 8M (X8) | A0 – A11 |
| 32M X 40 | 32M (X8) | TBD |

* NOTE: The BASE MEMORY DEVICE columns give the total device capacity in bits and the data interface word width.

NOTE: There shall be one bypass capacitor between VDD and VSS fore each memory device on the card. The value of the capacitors will be determined by the memory devices used.

## FIGURE 4.4.3–2 E
## 88 PIN, BY 40 DRAM CARD 1 BANK USING BY 8 DEVICES

**BLOCK DIAGRAM for 1M/4M/16M/64M X 40 USING X8 DRAM**




| WORD ORGANIZATION | *Base Memory Device D0 to D9 | ADDRESS FIELD |
|---|---|---|
| 1M X 40 | 4M (X8) | A0 – A9 |
| 4M X 40 | 16M (X8) | A0 – A10 |
| 16M X 40 | 64M (X8) | A0 – A11 |
| 64M X 40 | 256M (X8) | TBD |

* NOTE: The BASE MEMORY DEVICE columns give the total device capacity in bits and the data interface word width.

NOTE: There shall be one bypass capacitor between VDD and VSS fore each pair of memory devices on the card. The value of the capacitors will be determined by the memory devices used.

## FIGURE 4.4.3–2 F
## 88 PIN, BY 40 DRAM CARD 2 BANK USING BY 8 DEVICES

## 4.4.4 – 72 PIN DRAM SO–DIMM FAMILY

CAPACITY—512K, 1M, 2M, 4M, 8M, 16M, 32M, & 64M WORDS OF 32, OR 36 BITS
DATA CONFIGURATIONS—Two DATA Word configurations are defined:
—32 BIT
—36 BIT
CONFIGURATION—3 Different Configurations are defined using various combinationa of X4, X8, X9 memory devices.
LOGIC FEATURES—The modules contain "PRESENCE DETECT" features that consist of output pins in the PDn field that supply encoded values that define the storage capacity, configuration, data word configuration, refresh mode, and speed of the module.
VDD CHOICE—The choice of VDD value will be determined by the memory device used and defined by a mechanical interlock KEY
ENHANCEMENTS: In Release 6 Refresh was defined and new configurations were added.
PACKAGE—72 PIN JEDEC SO–DIMM MEMORY MODULE
PIN ASSIGNMENTS AND PD TABLES—Figs. 4.4.4–A
CAPACITY / DEVICE CONFIGURATION TABLE—Fig. 4.4.4–A
CONFIGURATION BLOCK DIAGRAM—Figs. 4.4.4–B through 4.4.4–D

| PIN NAME | PIN # | PIN # | PIN NAME |
|---|---|---|---|
| VSS | 1 | 2 | DQ0 |
| DQ1 | 3 | 4 | DQ2 |
| DQ3 | 5 | 6 | DQ4 |
| DQ5 | 7 | 8 | DQ6 |
| DQ7 | 9 | 10 | &VDD |
| PD1 | 11 | 12 | A0 |
| A1 | 13 | 14 | A2 |
| A3 | 15 | 16 | A4 |
| A5 | 17 | 18 | A6 |
| A10 | 19 | 20 | @ DQ8, NC |
| DQ9 | 21 | 22 | DQ10 |
| DQ11 | 23 | 24 | DQ12 |
| DQ13 | 25 | 26 | DQ14 |
| DQ15 | 27 | 28 | A7 |
| A11 | 29 | 30 | &VDD |
| A8 | 31 | 32 | A9 |
| $\overline{RE3}$ | 33 | 34 | $\overline{RE2}$ |
| DQ16 | 35 | 36 | @ DQ17, NC |
| DQ18 | 37 | 38 | DQ19 |
| VSS | 39 | 40 | $\overline{CE0}$ |
| $\overline{CE2}$ | 41 | 42 | $\overline{CE3}$ |
| $\overline{CE1}$ | 43 | 44 | $\overline{RE0}$ |
| $\overline{RE1}$ | 45 | 46 | A12 |
| $\overline{W}$ | 47 | 48 | A13 |
| DQ20 | 49 | 50 | DQ21 |
| DQ22 | 51 | 52 | DQ23 |
| DQ24 | 53 | 54 | DQ25 |
| @ DQ26, NC | 55 | 56 | DQ27 |
| DQ28 | 57 | 58 | DQ29 |
| DQ31 | 59 | 60 | DQ30 |
| &VDD | 61 | 62 | DQ32 |
| DQ33 | 63 | 64 | DQ34 |
| @ DQ35, NC | 65 | 66 | PD2 |
| PD3 | 67 | 68 | PD4 |
| PD5 | 69 | 70 | PD6 |
| PD7 | 71 | 72 | VSS |

TOP VIEW

| PRESENCE DETECT TRUTH TABLE | | | | | | | | Ave Refresh Interval (µs) | |
|---|---|---|---|---|---|---|---|---|---|
| MOD CONFIG | DEVICE | ADDR | | PD4 | PD3 | PD2 | PD1 | | |
| | | ROW | COL | Pin 68 | Pin 67 | Pin 66 | Pin 11 | Normal | Long |
| NO MODULE | | | | O | O | O | O | | |
| 512K X 32/36 | 512K X 8/9 | 10 | 9 | O | S | S | S | 15.6 | 125 |
| 1M X 32/36 | 512K X 8/9 | 10 | 9 | S | S | S | S | 15.6 | 125 |
| 1M X 32/36 | 1M X 2/4/16/18 | 10 | 10 | O | S | S | O | 15.6 | 125 |
| 1M X 32/36 | 1M X 16/18 | 12 | 8 | O | O | S | O | 15.6 | 31.2 |
| 2M X 32/36 | 1M X 2/4/16/18 | 10 | 10 | S | S | S | O | 15.6 | 125 |
| 2M X 32/36 | 1M X 16/18 | 12 | 8 | S | O | S | O | 15.6 | 31.2 |
| 2M X 32/36 | 2M X 8/9 | 11 | 10 | O | S | O | S | 15.6 | 62.4 |
| 4M X 32/36 | 2M X 8/9 | 11 | 10 | S | S | O | S | 15.6 | 62.4 |
| 4M X 32/36 | 4M X 2/416/18 | 12* | 10* | O | S | O | O | 15.6 | 31.2 |
| | or | 11* | 11* | | | | | | 62.4 |
| 8M X 32/36 | 4M X 2/4/16/18 | 12* | 10* | S | S | O | O | 15.6 | 31.2 |
| | or | 11* | 11* | | | | | | 62.4 |
| 8M X 32/36 | 8M X 8/9 | 12 | 11 | O | O | S | S | 15.6 | 31.2 |
| 16M X 32/36 | 8M X 8/9 | 12 | 11 | S | O | S | S | 15.6 | 31.2 |
| 16M X 32/36 | 16M X 2/4/16/18 | 13 | 11 | O | O | O | S | 15.6 | TBD |
| 32M X 32/36 | 16M X 2/4/16/18 | 13 | 11 | S | O | O | S | 15.6 | TBD |
| 32M X 32/36 | 32M X 8/9 | TBD | TBD | O | S | S | S | TBD | TBD |
| 64M X 32/36 | 32M X 8/9 | TBD | TBD | S | S | S | S | TBD | TBD |
| 64M X 32/36 | 64M X 2/4 | TBD | TBD | O | S | S | O | TBD | TBD |

* Indicates that 12/10 or 11/11 may be used on this assembly. The application must determine the appropriate addressing version or provide redundant (12/11) addressing to allow the use of either.

** The DRAM organization is provided for reference and clarification only. X2 implies X2 DRAM with 2 $\overline{CE}$s. X4 can be either X4 or X4 with 4 CEs. X1 options are allowed if approved dimensions are met.

O = OPEN CIRCUIT (NO CONNECTION)

S = CONNECTED TO VSS

| | PD6 | PD5 |
|---|---|---|
| SPEED (tRAC) | Pin 70 | Pin 69 |
| 80 ns | S | O |
| 70 ns | O | S |
| 60 ns | O | O |
| 50 ns | S | S |
| | | |
| PD SPEED TABLE | | |

| | PD7 |
|---|---|
| REFRESH MODE | Pin 71 |
| NORMAL | O |
| * SELF-REFRESH | S |
| REFRESH MODE | |

*SELF-REFRESH/LONG INTERVA

&Note: This standard allows for the use of different values of VDD depending on the memory device requirements. A mechanical key is used to define the voltage as described in the package registration document, MO–160.

@ These Pins are NC for X32, and DQn for X36 modules

## FIGURE 4.4.4–A
## 32 OR 36 BIT DRAM SO–DIMM PINOUT

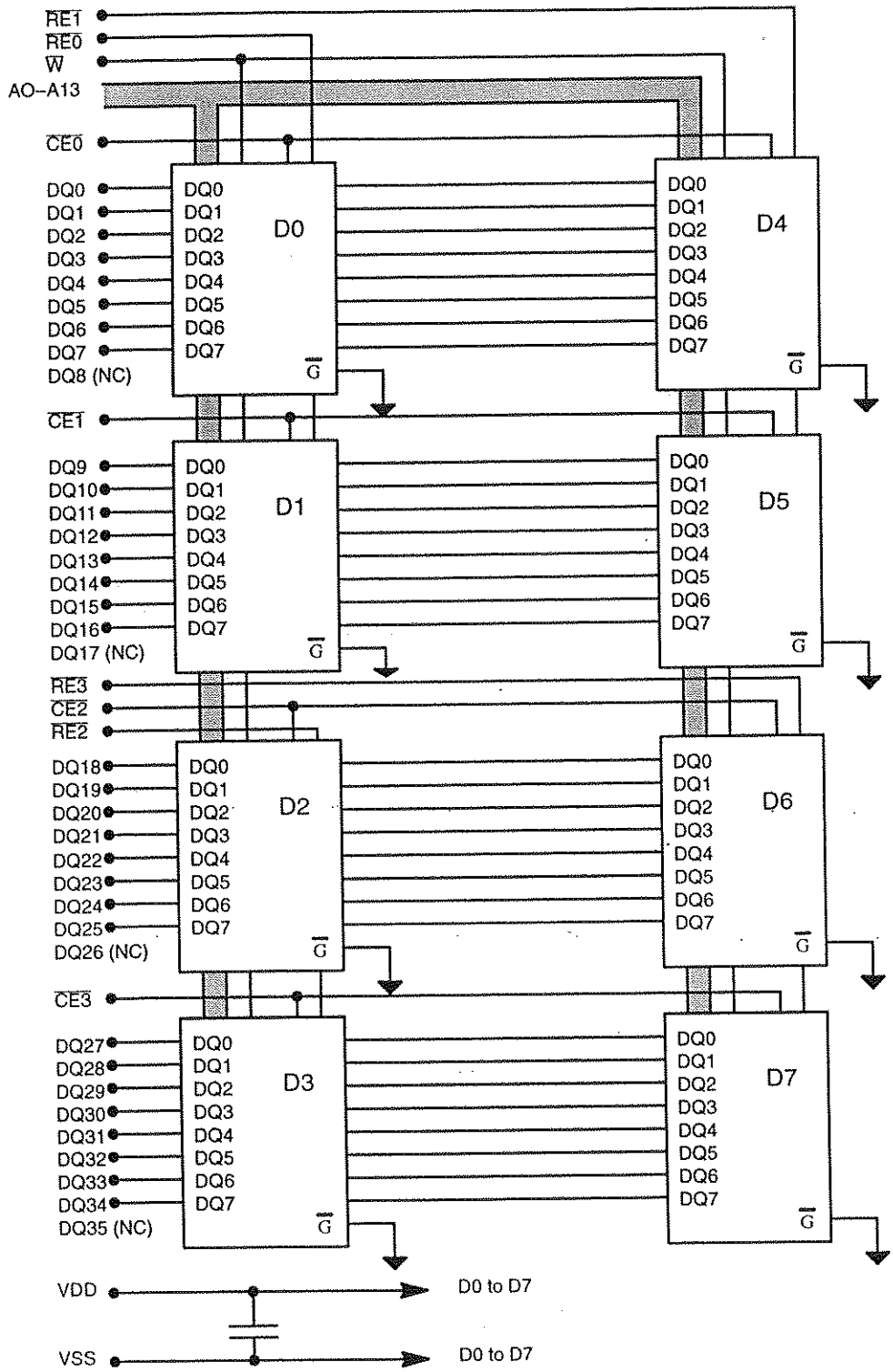



**FIGURE 4.4.4–B**
**BLOCK DIAGRAM for X 32 DRAM SO–DIMM USING X8 DRAM**
Release 5c7

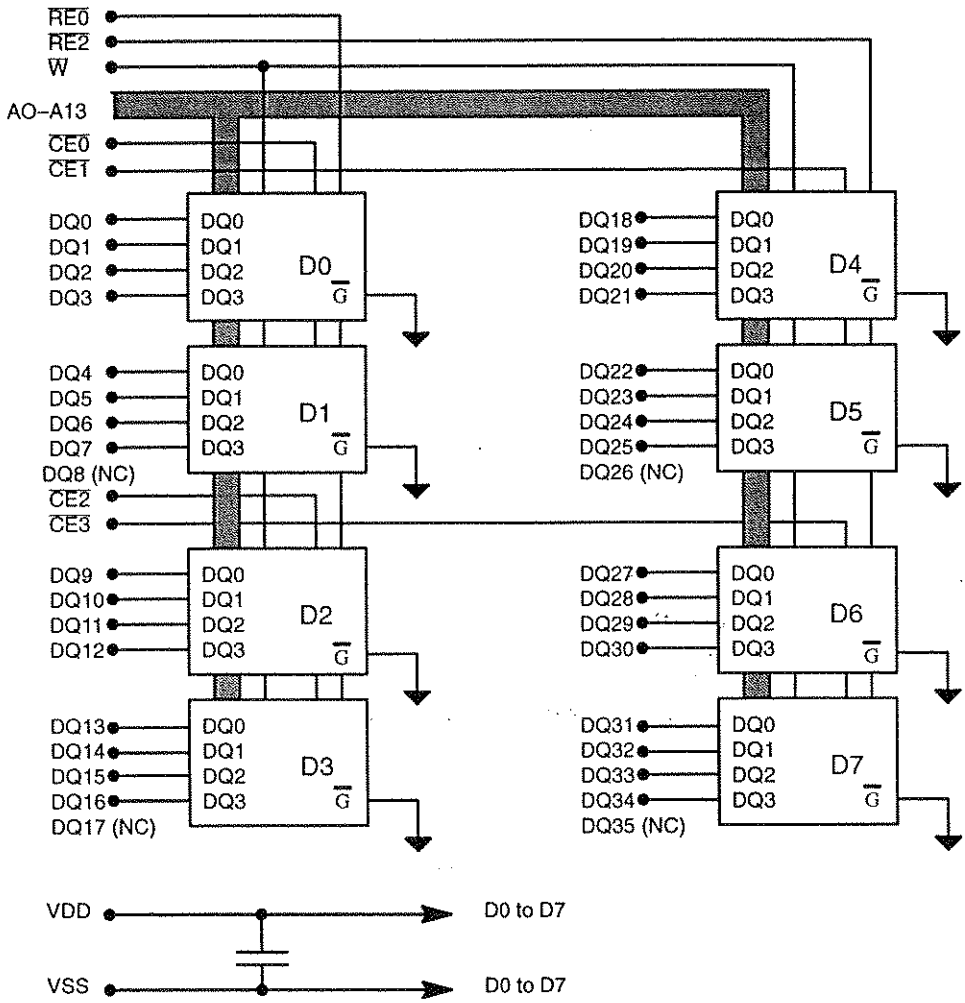



**FIGURE 4.4.4–C**
**BLOCK DIAGRAM for X 32 DRAM SO–DIMM USING X4 DRAM**

Release 5c7

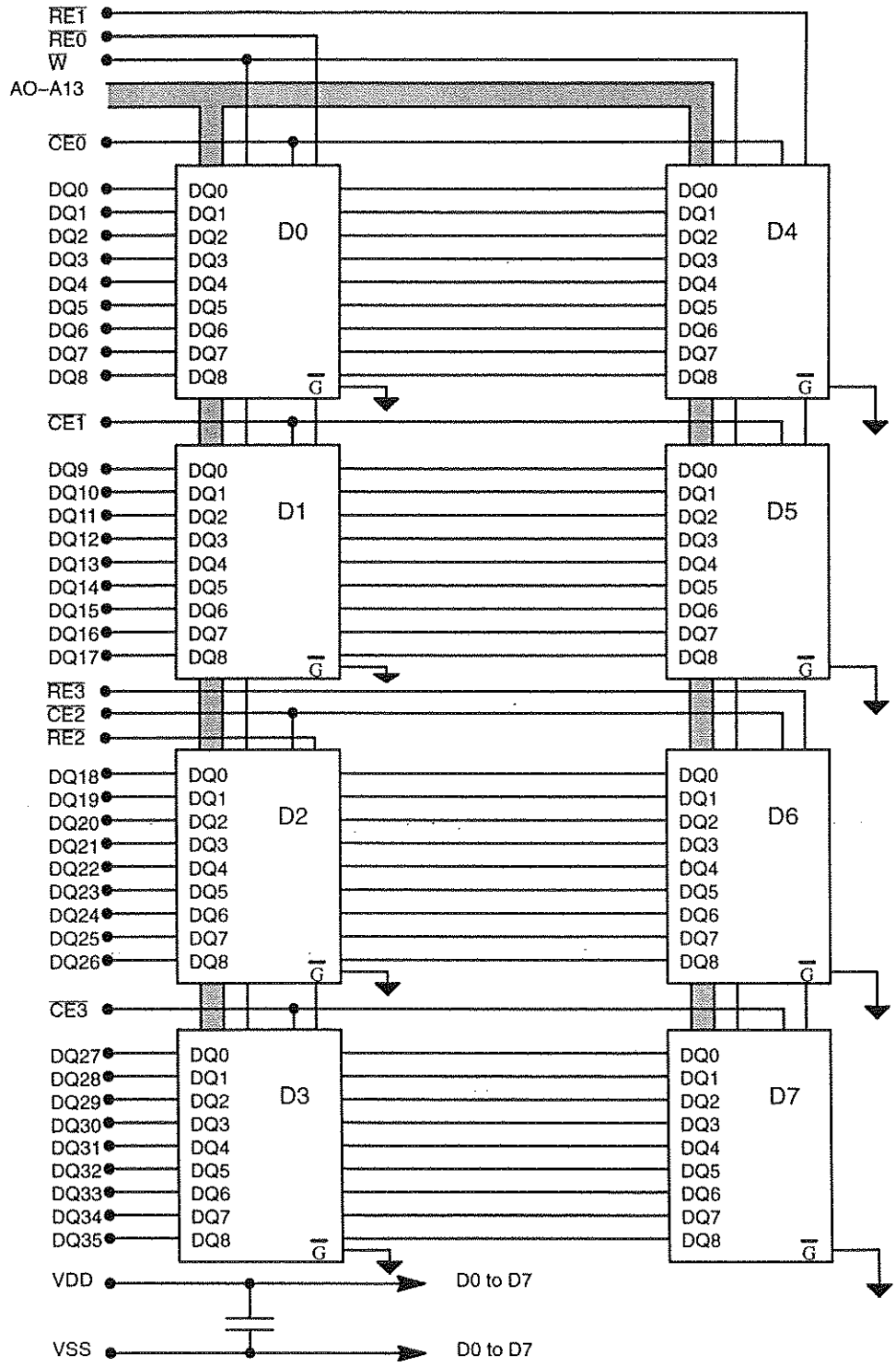



**FIGURE 4.4.4–D**
**BLOCK DIAGRAM for X 36 DRAM SO–DIMM USING X9 DRAM**
Release 5c7

## 4.4.5 – 88 PIN DRAM SO–DIMM FAMILY

CAPACITY—512K TO 128M WORDS OF 32, OR 36 BITS
DATA CONFIGURATIONS—Two DATA Word configurations are defined: X32 & X36
CONFIGURATION—4 Different Configurations are defined using various combinationa of X1, X4, X8, memory devices.
LOGIC FEATURES—The modules contain "PRESENCE DETECT" features that consist of output pins in the PDn field that supply encoded values that define the storage capacity, configuration, data word configuration, refresh mode, and speed of the module.
VDD CHOICE—The choice of VDD value will be determined by the memory device used and defined by a mechanical interlock KEY
PACKAGE—88 PIN JEDEC SO–DIMM MEMORY MODULE
PIN ASSIGNMENTS —Figs. 4.4.5–A
PD, CAPACITY / DEVICE CONFIGURATION TABLES—Fig. 4.4.5–B
CONFIGURATION BLOCK DIAGRAM—Figs. 4.4.5–C through 4.4.5–F

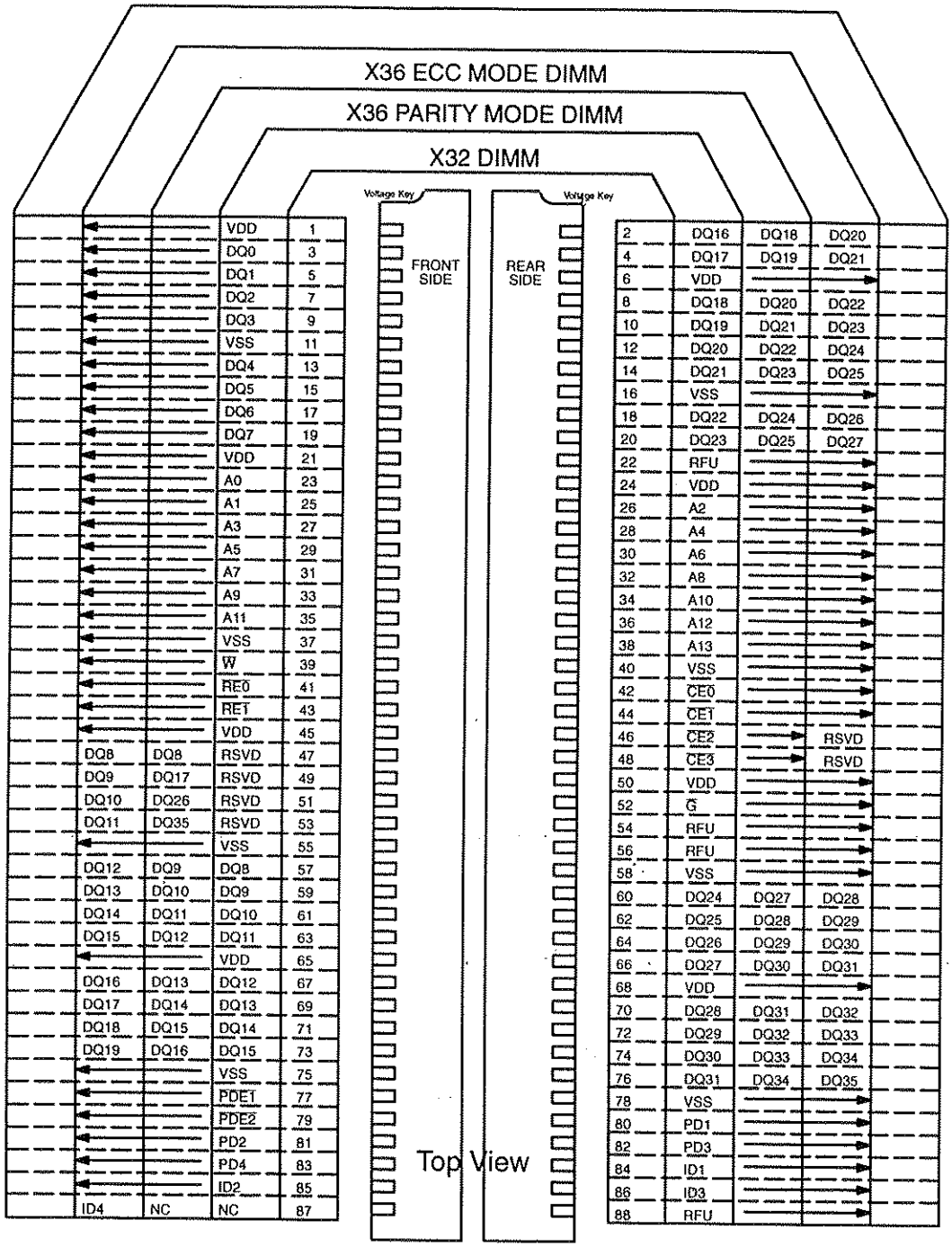



**FIGURE 4.4.5–A**
**X32 and X36 DRAM SO–DIMM PINOUT**

Release 6c7

| PREOENCE DETECT TRUTH TABLE | | | | | | | |
|---|---|---|---|---|---|---|---|
| MOD CONFIG | DEVICE | ADDR | | PD14 | PD13 | PD12 | PD11 |
| | | ROW | COL | | | | |
| NO MODULE | | | | 1 | 1 | 1 | 1 |
| 512K X 32/36 | 512K X 8/9 | 10 | 9 | 1 | 0 | 0 | 0 |
| 1M X 32/36 | 512K X 8/9 | 10 | 9 | 0 | 0 | 0 | 0 |
| 1M X 32/36 | 1M X 1/4/16/18 | 10 | 10 | 1 | 0 | 0 | 1 |
| 1M X 32/36 | 1M X 16/18 | 12 | 8 | 1 | 0 | 1 | 0 |
| 2M X 32/36 | 1M X 1/4/16/18 | 10 | 10 | 0 | 0 | 0 | 1 |
| 2M X 32/36 | 1M X 16/18 | 12 | 8 | 0 | 0 | 1 | 0 |
| 2M X 32/26 | 2M X 1/2/8/9 | 11 | 10 | 1 | 0 | 1 | 1 |
| 4M X 32/36 | 2M X 1/2/8/9 | 11 | 10 | 0 | 0 | 1 | 1 |
| 4M X 32/36 | 4M X 4/16/18 | 12 | 10 | 1 | 1 | 0 | 0 |
| 4M X 32/36 | 4M X 1/4/16/18 | 11 | 11 | 1 | 1 | 0 | 1 |
| 8M X 32/36 | 4M X 4/16/18 | 12 | 10 | 0 | 1 | 1 | 1 |
| 8M X 32/36 | 4M X 1/4/16/18 | 11 | 11 | 0 | 1 | 0 | 1 |
| 8M X 32/36 | 8M X 1/2/8/9 | 12 | 11 | 1 | 1 | 1 | 0 |
| 16M X 32/36 | 8M X 1/2/8/9 | 12 | 11 | 0 | 1 | 1 | 0 |
| 16M X 32/36 | 16M X 1/4/16/18 | 13/12* | 11/12* | 1 | 0 | 0 | 0 |
| 32M X 32/36 | 16M X 1/4/16/18 | 13/12* | 11/12* | 0 | 0 | 0 | 0 |
| 32M X 32/36 | 32M X 1/2/8/9 | TBD | TBD | 1 | 0 | 0 | 1 |
| 64M X 32/36 | 32M X 1/2/8/9 | TBD | TBD | 0 | 0 | 0 | 1 |
| 64M X 32/36 | 64M X 1/4 | TBD | TBD | 1 | 0 | 1 | 0 |
| 128M X 32/36 | 64M X 1/4 | TBD | TBD | 0 | 0 | 1 | 0 |

NOTE 1 – * This addressing includes a redundant address to allow mixing of 13/11 and 12/12 devices.

NOTE 2 – The PDmn & IDn values given in the tables have the following significance: 1 = Driven to LOGIC HIGH for PD, OPEN CIRCUIT FOR ID
0 = Driven to LOGIC LOW for PD, SHORT TO VSS FOR ID

NOTE 3 – #The PDmn values are multiplexed onto the PDn pins under the control of $\overline{PDE1}$ and $\overline{PDE2}$ as follows:
PD11 ⇒ PD14 to PD1 ⇒ PD4 WITH $\overline{PDE1}$ = LOW
PD21 ⇒ PD24 to PD1 ⇒ PD4 WITH $\overline{PDE2}$ = LOW

NOTE4: This standard allows for the use of different values of VDD depending on the memory device requirements. A mechanical key is used to define the voltage as described in the package registration document.

| | ID3 |
|---|---|
| PARITY | |
| X32 NO–PAR. | 0 |
| X36 PARITY | 1 |
| PARITY STRUCTURE | |

| | ID2 |
|---|---|
| REFRESH MODE | |
| NORMAL | 0 |
| SELF–REFRESH | 1 |
| REFRESH MODE | |

| | ID1 |
|---|---|
| REFRESH | |
| NORMAL | 0 |
| SLOW | 1 |
| REFRESH PERIOD | |

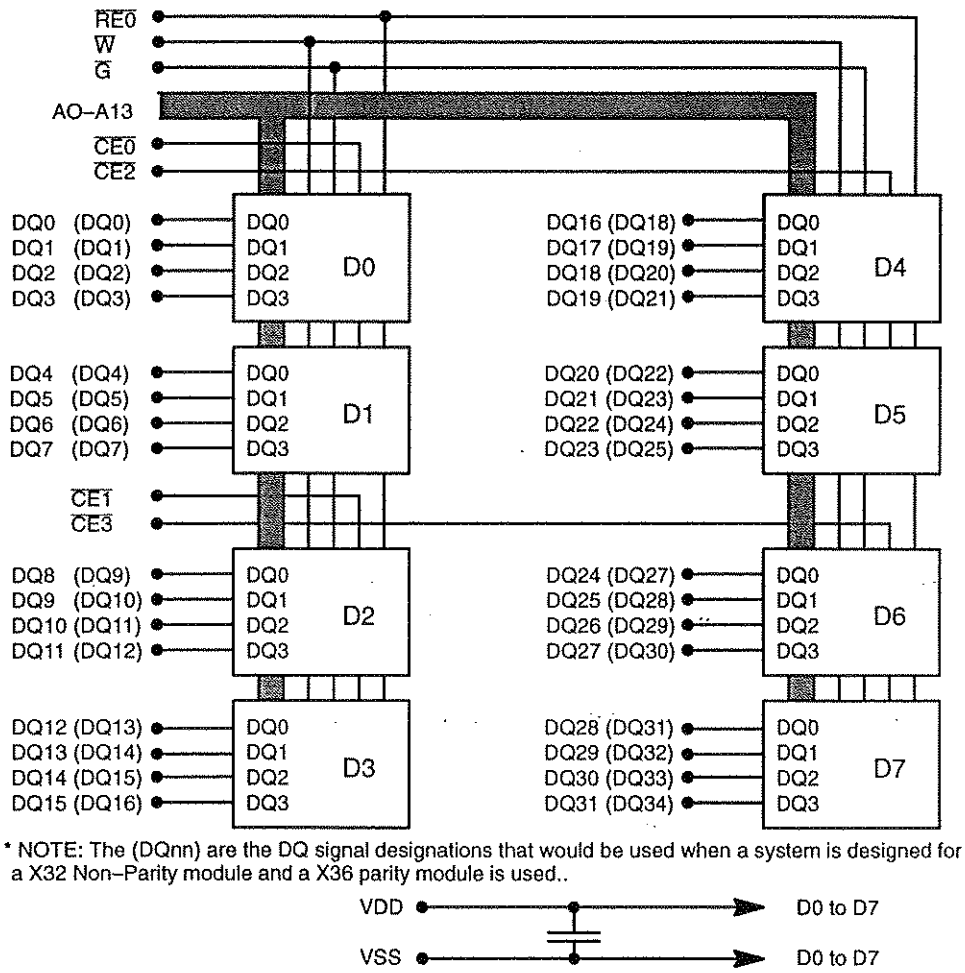
| | PD24 |
|---|---|
| ECC | |
| X32/X36 PARITY | 1 |
| X36 ECC | 0 |
| DATA STRUCTURE | |

| | PD23 |
|---|---|
| MODE | |
| FAST PAGE | 1 |
| EDO/BURST EDO | 0 |
| DATA I/O MODE | |

| | PD22 | PD21 |
|---|---|---|
| SPEED (tRAC) | 81 | 80 |
| 80 ns | 0 | 1 |
| 70 ns | 1 | 0 |
| 60 ns | 1 | 1 |
| 50 ns | 0 | 0 |
| 40 ns | 0 | 1 |
| PD SPEED TABLE | | |

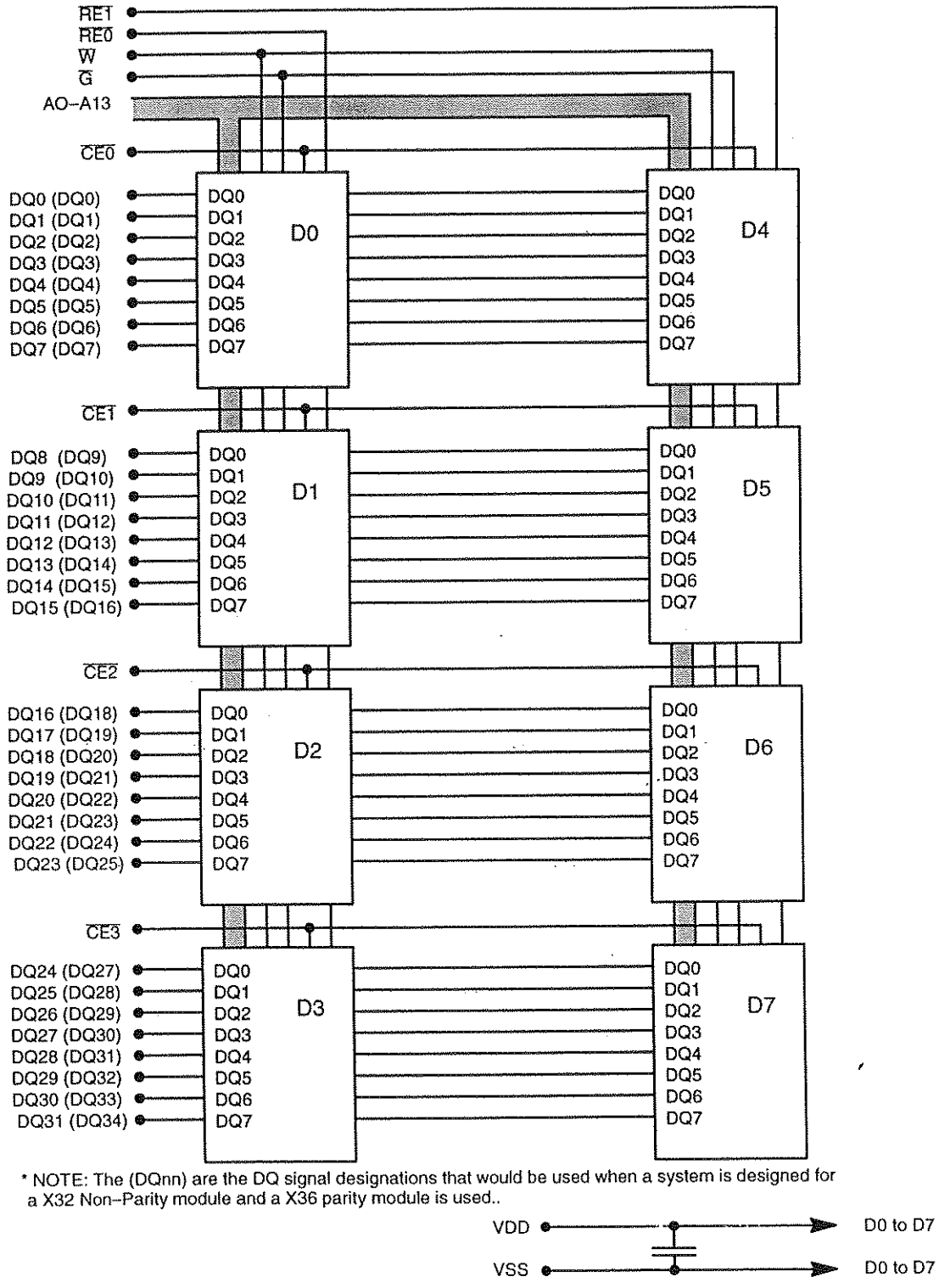
&

## FIGURE 4.4.5–B
## X32 and X36 DRAM SO–DIMM PD and ID TRUTH TABLES



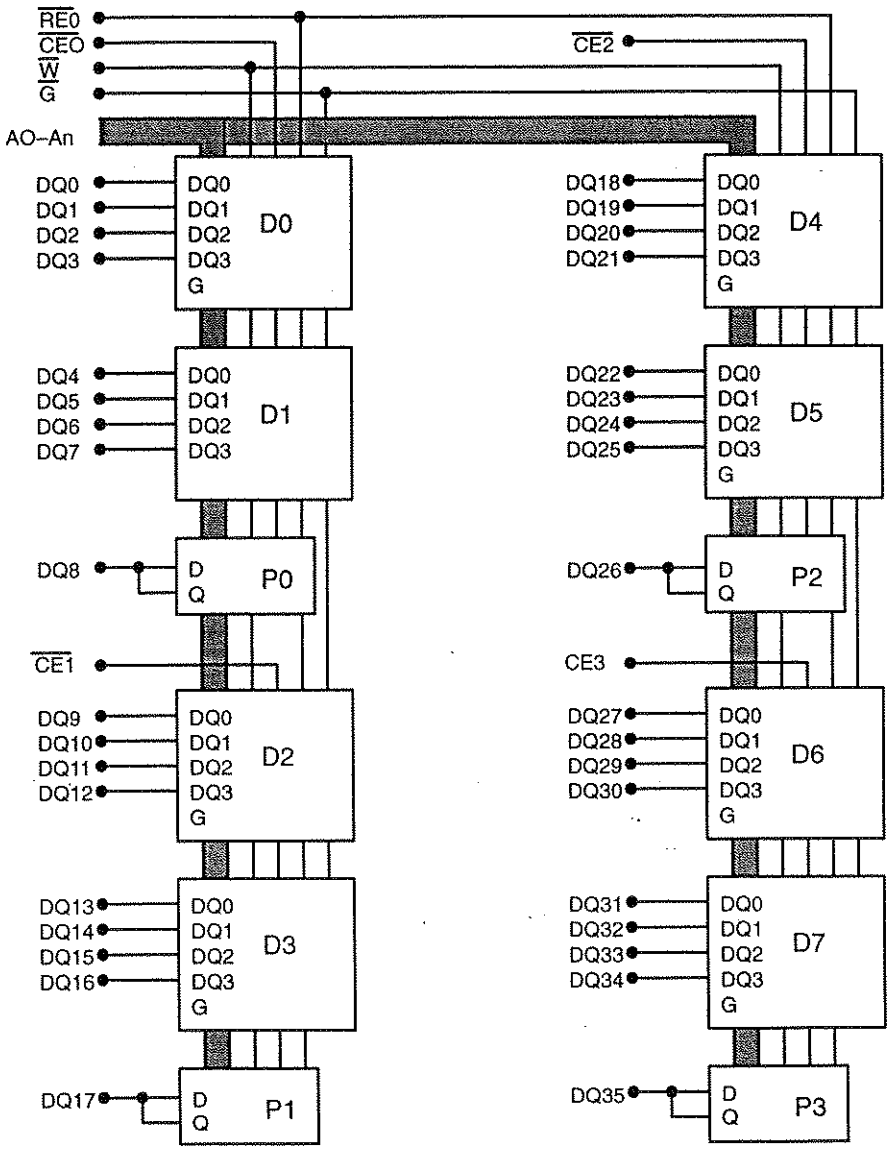

* NOTE: The (DQnn) are the DQ signal designations that would be used when a system is designed for a X32 Non–Parity module and a X36 parity module is used..

## FIGURE 4.4.5–C
## X 32 DRAM SO–DIMM USING X4 DEVICES




* NOTE: The (DQnn) are the DQ signal designations that would be used when a system is designed for a X32 Non–Parity module and a X36 parity module is used..

## FIGURE 4.4.5–D
## X 32 DRAM SO–DIMM USING X8 DEVICES




* NOTE: For the parity bit devices, P0 ⇒ P3, X1 DRAMs are showed, but Multi $\overline{CE}$ DRAM may be used.

## FIGURE 4.4.5–E
## X 36 DRAM PARITY SO–DIMM USING X4/X1 DEVICES

Release 6–7

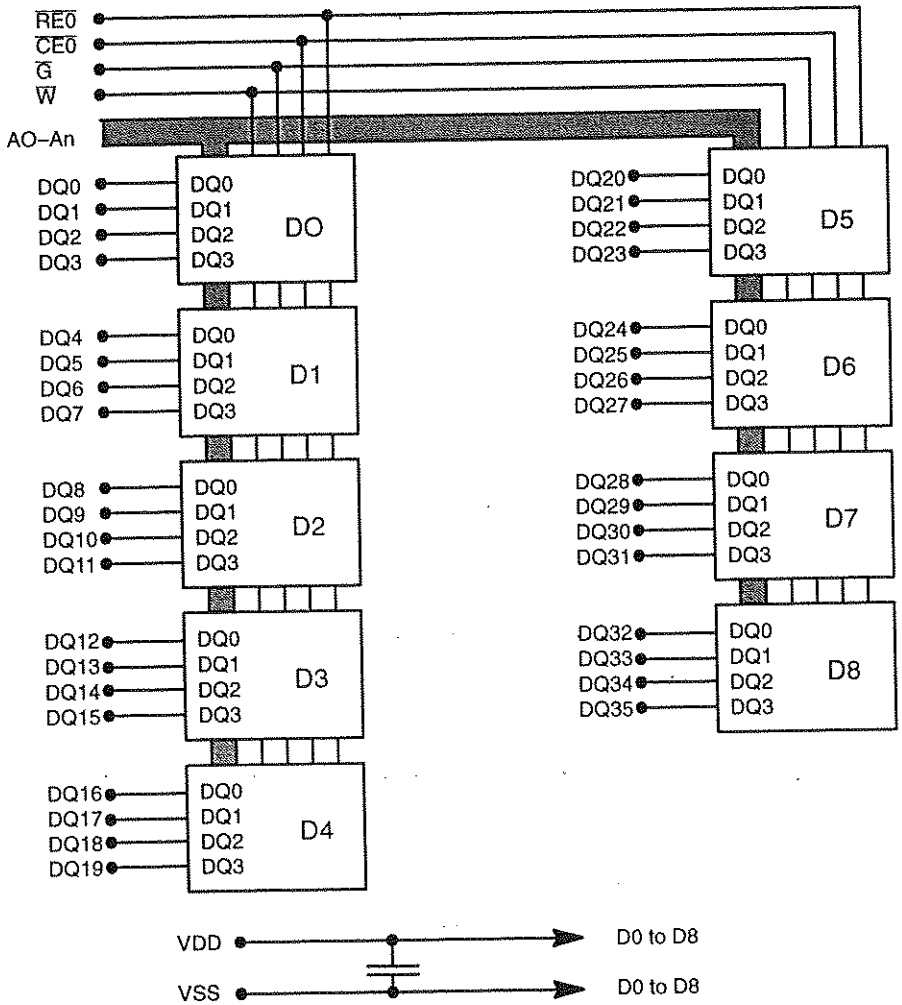


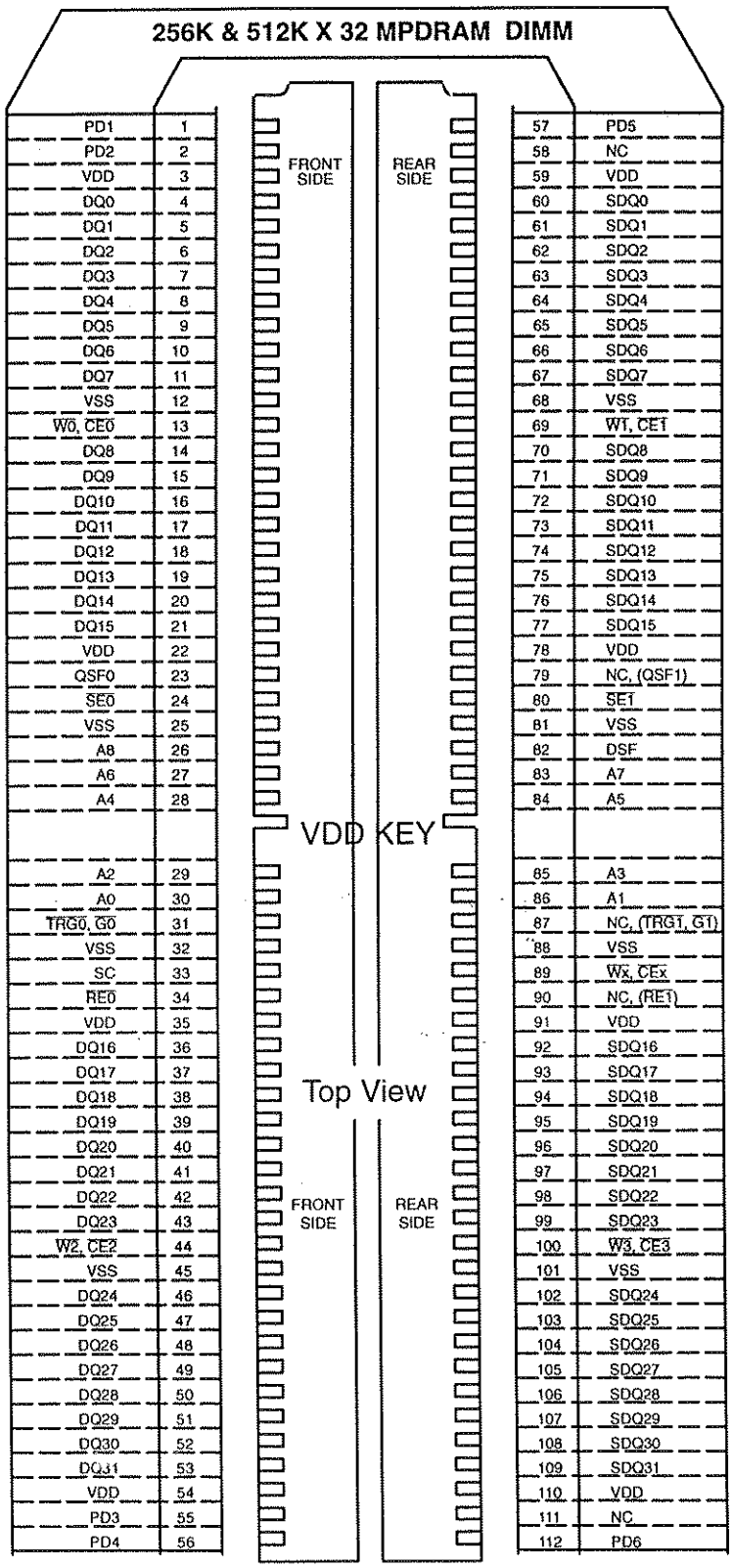

**FIGURE 4.4.5–F**
**X 36 DRAM ECC SO–DIMM USING X4 DEVICES**

## 4.4.6 – 112 PIN MPDRAM DIMM FAMILY

CAPACITY—256K, and 512K WORDS OF 32 BITS ON THE SERIAL AND PARALLEL PORTS.
DATA CONFIGURATIONS—Two DEVICE configurations are defined: using X8 and X16 MPDRAM
CONFIGURATION—2 Different Configurations are defined using X4 & X8 memories with 2 banks.
LOGIC FEATURES—The modules contain independent clock control of the 4 separate BYTE groups of data bits and "PRESENCE DETECT" features that consists of output pins in the PDn field which supplies encoded values that define the storage capacity, SAM length, read mode, refresh mode, $\overline{CE}/W$ logic configuration, and speed of the module.
PACKAGE—112 PIN JEDEC DIMM MEMORY MODULE
PIN ASSIGNMENTS AND PD TABLES—Figs. 4.4.6–A
PRESENCE DETECT TABLES—Fig. 4.4.6–B
CONFIGURATION BLOCK DIAGRAM—Figs. 4.4.6–B & 4.4.6–C

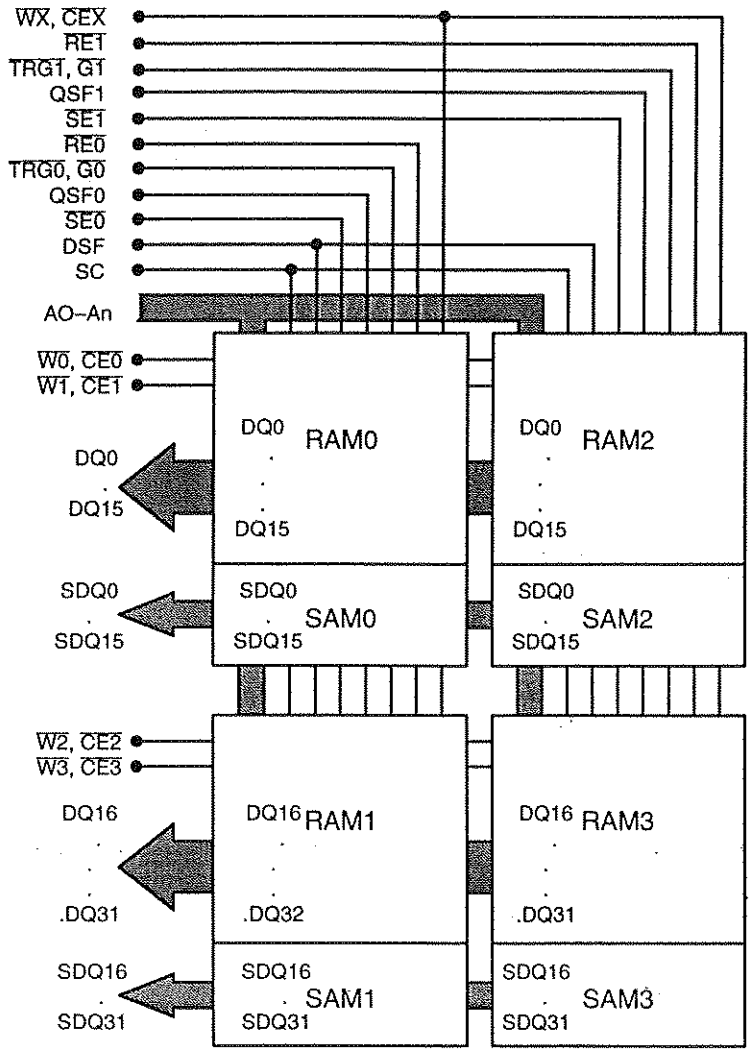


XILINX EXHIBIT 1012
Page 273




NOTE: Pin functions in ( ) may be re;quired on certain 2–bank 512K X 32 module implementations

**FIGURE 4.4.6–A**
**256K & 512K MPDRAM DIMM**




**BLOCK DIAGRAM for 256K/512K X 32 DIMM WITH 256K BY 16 MPDRAM**

| CAPACITY | |
|---|---|
| | PD1 |
| | Pin 1 |
| 1MB | S |
| 2MB | O |

| SAM LENGTH | |
|---|---|
| | PD2 |
| | Pin 2 |
| 256 | S |
| 512 | O |

| OPERATIONAL MODE | |
|---|---|
| | PD3 |
| | Pin 55 |
| Fast Page | S |
| EDO | O |

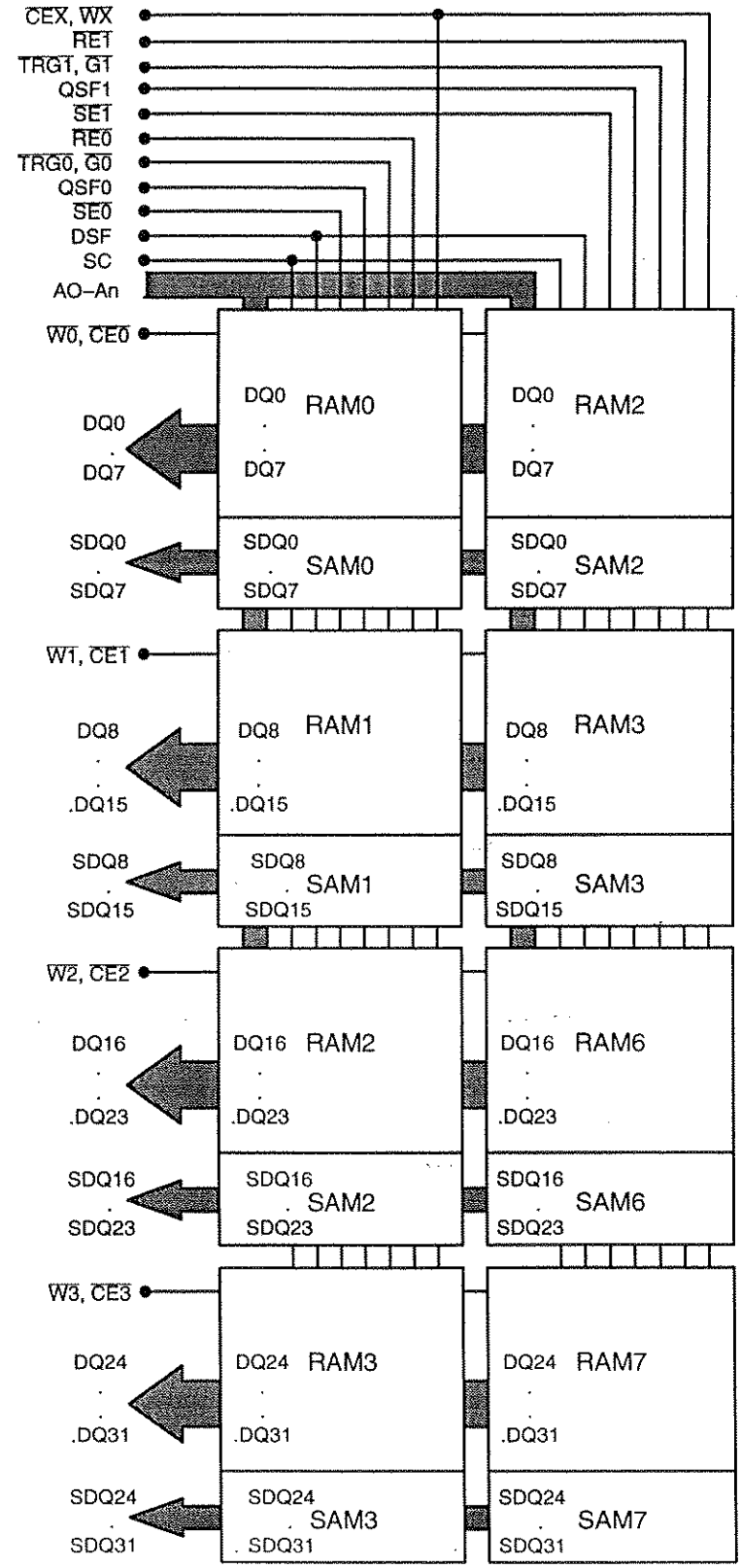
| BYTE CONTROL | |
|---|---|
| | PD6 |
| | Pin 112 |
| 4 $\overline{CE}$ | S |
| 4 $\overline{W}$ | O |

| PD SPEED TABLE | | |
|---|---|---|
| | PD4 | PD5 |
| SPEED (tRELQV) | Pin 56 | Pin 57 |
| 80 ns | O | O |
| 70 ns | S | O |
| 60 ns | O | S |
| 50 ns | S | S |

S = CONNECTED TO VSS
O = NO CONNECTION

**PD TRUTH TABLES for 256K/512K X 32 DIMM WITH 256K BY 8 or 16 MPDRAM**

## FIGURE 4.4.6–B
## 256K/512K BY 32 MPDRAM DIMM WITH 256K BY 16 MPDRAM




**BLOCK DIAGRAM for 256K/512K X 32 DIMM WITH 256K BY 8 MPDRAM**

**FIGURE 4.4.6–C**

**256K/512K BY 32 MPDRAM DIMM WITH 256K BY 8 MPDRAM**

## 4.4.7 – 80 PIN EEPROM SIMM FAMILY

CAPACITY—128K, 256K, 512K, 1M, 2M, 4M, & 8M WORDS OF 32 BITS
CONFIGURATION—Fifteen Different Configurations Using 1mb, 4mb, & 16mb Devices.
LOGIC FEATURES—The modules contain a "PRESENCE DETECT" feature which conists of output pins which supply an encoded value which defines the storage capacity, configuration, and speed of the module.
PACKAGE—88 PIN JEDEC MEMORY MODULE
PIN ASSIGNMENTS AND PD TABLES—Fig. 4.4.7–A
CONFIGURATION BLOCK DIAGRAM—Figs. 4.4.7–B

XILINX EXHIBIT 1012
Page 278

| PIN # | PIN NAME | PIN # | PIN NAME |
|---|---|---|---|
| 1 | VSS | 41 | A11 |
| 2 | VDD | 42 | A10 |
| 3 | VPP/NC | 43 | A9 |
| 4 | $\overline{G}$ | 44 | A8 |
| 5 | $\overline{W0}$ | 45 | A7 |
| 6 | $\overline{W1}$ | 46 | A6 |
| 7 | RFU | 47 | A5 |
| 8 | DQ16 | 48 | A4 |
| 9 | DQ17 | 49 | A3 |
| 10 | DQ18 | 50 | A2 |
| 11 | DQ19 | 51 | A1 |
| 12 | DQ20 | 52 | A0 |
| 13 | DQ21 | 53 | $\overline{W3}$ |
| 14 | DQ22 | 54 | VSS |
| 15 | DQ23 | 55 | DQ15 |
| 16 | DQ24 | 56 | DQ14 |
| 17 | DQ25 | 57 | DQ13 |
| 18 | DQ26 | 58 | DQ12 |
| 19 | DQ27 | 59 | DQ11 |
| 20 | DQ28 | 60 | DQ10 |
| 21 | $\overline{E3}$ | 61 | DQ9 |
| 22 | $\overline{E2}$ | 62 | DQ8 |
| 23 | $\overline{E1}$ | 63 | DQ7 |
| 24 | $\overline{E0}$ | 64 | DQ6 |
| 25 | VSS | 65 | DQ5 |
| 26 | DQ29 | 66 | DQ4 |
| 27 | DQ30 | 67 | DQ3 |
| 28 | DQ31 | 68 | DQ2 |
| 29 | $\overline{W2}$ | 69 | DQ1 |
| 30 | A22 | 70 | DQ0 |
| 31 | A21 | 71 | VPP/NC |
| 32 | A20 | 72 | VDD |
| 33 | A19 | 73 | PD1 |
| 34 | A18 | 74 | PD2 |
| 35 | A17 | 75 | PD3 |
| 36 | A16 | 76 | PD4 |
| 37 | A15 | 77 | PD5 |
| 38 | A14 | 78 | PD6 |
| 39 | A13 | 79 | PD7 |
| 40 | A12 | 80 | VSS |

**PRESENCE DETECT TRUTH TABLE**

| Module Organization | Device Density | # of Dev. | Module Capacity | PD1 | PD2 | PD3 | PD4 |
|---|---|---|---|---|---|---|---|
| No Module | | | | 1 | 1 | 1 | 1 |
| .128K X 32 | 1M | 4 | 512KB | 0 | 1 | 1 | 1 |
| 256K X 32 | 1M | 8 | 1MB | 1 | 0 | 1 | 1 |
| 512K X 32 | 1M | 16 | 2MB | 0 | 0 | 1 | 1 |
| 256K X 32 | 2M | 4 | 1MB | 1 | 1 | 0 | 1 |
| 512K X 32 | 2M | 8 | 2MB | 0 | 1 | 0 | 1 |
| 1M X 32 | 2M | 16 | 4MB | 1 | 0 | 0 | 1 |
| 512K X 32 | 4M | 4 | 2MB | 0 | 0 | 0 | 1 |
| 1M X 32 | 4M | 8 | 4MB | 1 | 1 | 1 | 0 |
| 2M X 32 | 4M | 16 | 8MB | 0 | 1 | 1 | 0 |
| 1M X 32 | 8M | 4 | 4MB | 1 | 0 | 1 | 0 |
| 2M X 32 | 8M | 8 | 8MB | 0 | 0 | 1 | 0 |
| 4M X 32 | 8M | 16 | 16MB | 1 | 1 | 0 | 0 |
| 2M X 32 | 16M | 4 | 8MB | 0 | 1 | 0 | 0 |
| 4M X 32 | 16M | 8 | 16MB | 1 | 0 | 0 | 0 |
| 8M X 32 | 16M | 16 | 32MB | 0 | 0 | 0 | 0 |

1 = OPEN CIRCUIT (NO CONNECTION)
0 = CONNECTED TO VSS

**MODULE SPEED IDENTIFICATION**

| MAX ACCESS TIME | PRESENCE DETECT PIN | | |
|---|---|---|---|
| | PD5 | PD6 | PD7 |
| NOT DEFINED | 1 | 1 | 1 |
| 45 nS | 0 | 1 | 1 |
| 55 nS | 1 | 0 | 1 |
| 70 nS | 0 | 0 | 1 |
| 90 nS | 1 | 1 | 0 |
| 120 nS | 0 | 1 | 0 |
| 150 nS | 1 | 0 | 0 |
| 200 nS | 0 | 0 | 0 |

NOTE – This family of pinouts is approved for use in SIMM package that is nominally 4.65" long and a height of 0.85" See JEDEC Publication 95, section MO–XXX.

## FIGURE 4.4.7–A
## 128K TO 8M BY 32 EEPROM SIMM, PINOUT AND PD TABLES

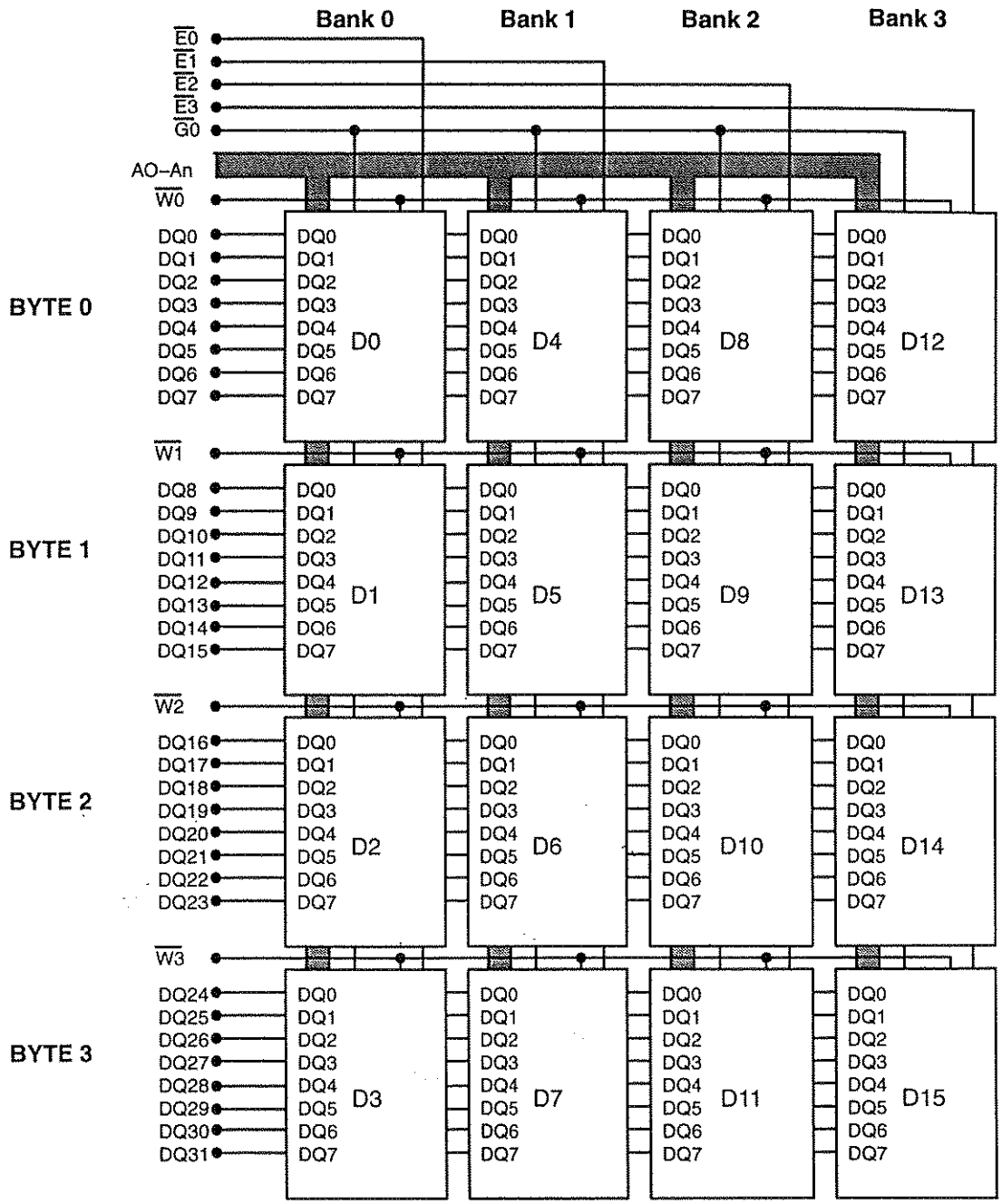



**FIGURE 4.4.7–B**
**128K TO 8M BY 32 EEPROM SIMM BLOCK DIAGRAM**

## 4.4.8 – 100 PIN DRAM, SDRAM & ROM DIMM FAMILY

CAPACITY—up to the addressing capacity of 16 bits, address multiplexed with words of 32, 36, & 40 bits.

DATA CONFIGURATIONS—Seven DATA Word configurations are defined:
—32 BIT DRAM & SDRAM without PARITY
—36 BIT DRAM & SDRAM for ECC CODES
—40 BIT DRAM & SDRAM for ECC CODES
—32 BIT MULTIPLEXED ROM without PARITY.

CONFIGURATION—26 Different Configurations are defined using various combinationa of X1, X4, X8, and X16 DRAM & SDRAM memories including 2 bank configurations, 5 for DRAM and 21 for SDRAM.

LOGIC FEATURES—The modules contain the Serial Presence Detect (SPD) feature that conist of a built in serial access EEPROM that stores information on mutiple parameters and attributes of the module such as technology, storage capacity, configuration, data word configuration, refresh mode, and speed of the module.

PACKAGE—100 PIN JEDEC DIMM MEMORY MODULE

PIN ASSIGNMENTS —Figs. 4.4.8–A & 4.4.8–B

TECHNOLOGY COMPARISON TABLE — Fig. 4.4.8–C

SDRAM CLOCK WIRING DIAGRAMS — Fig. 4.4.8–D

SDRAM CONFIGURATION BLOCK DIAGRAMS —Figs. 4.4.8–E through 4.4.8–Z

DRAM CONFIGURATION BLOCK DIAGRAMS —Figs. 4.4.8–AA through 4.4.8–AE



XILINX EXHIBIT 1012
Page 281

XILINX EXHIBIT 1012
Page 282

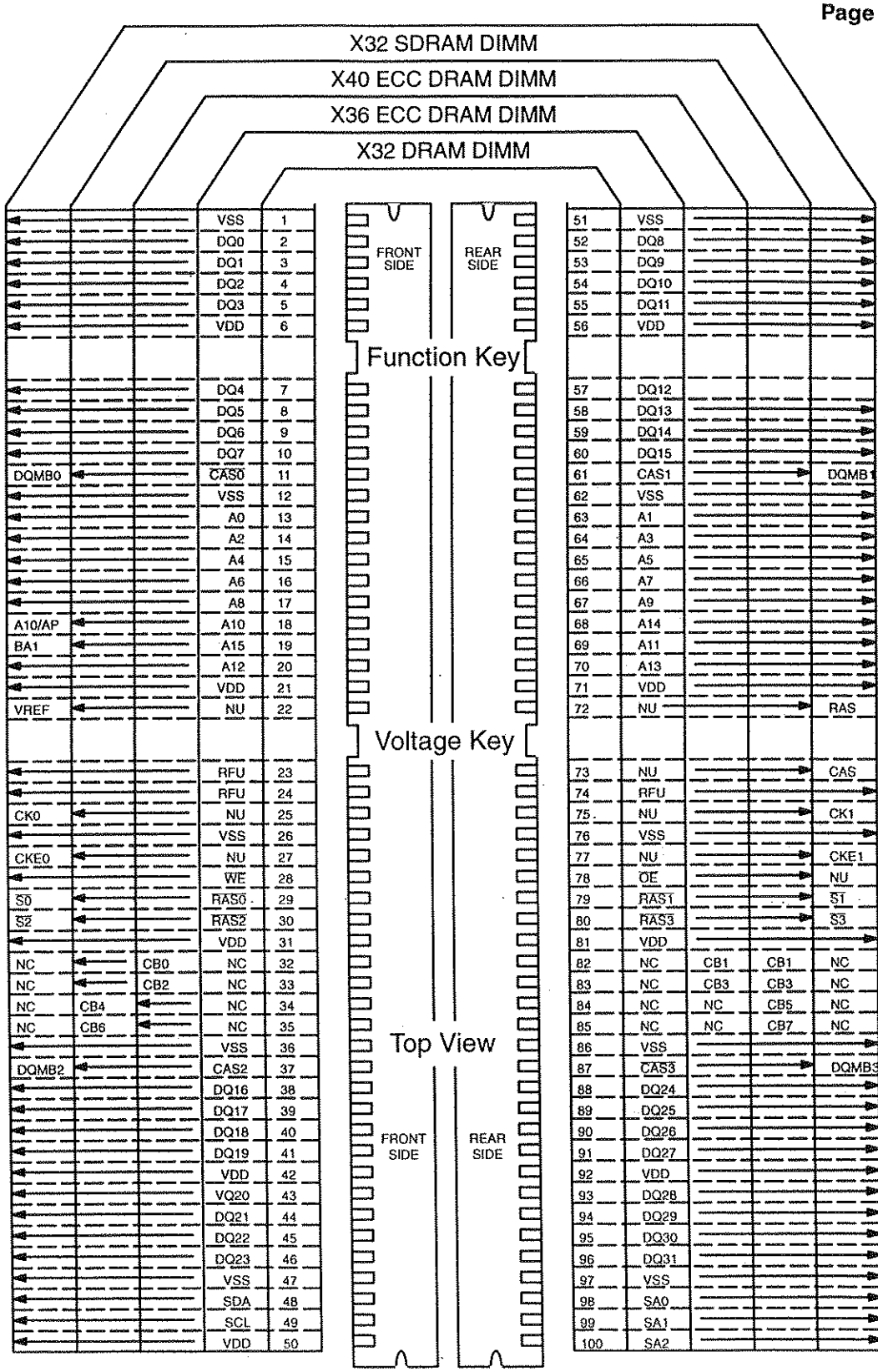



**FIGURE 4.4.8– B**

**100 Pin 32, 36, or 40 BIT DRAM, 32 BIT SDRAM DIMM PINOUT**

Release 7

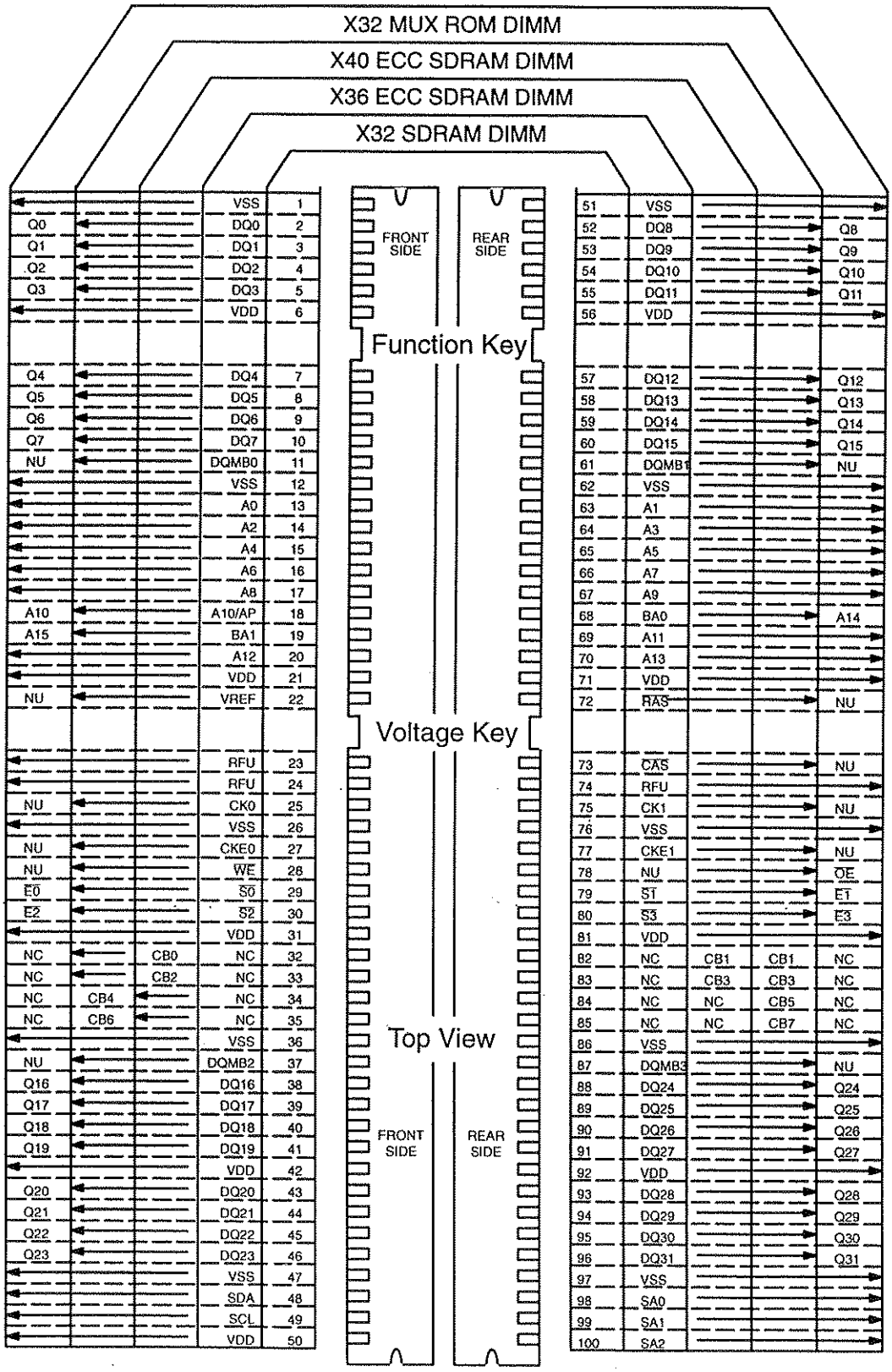



**FIGURE 4.4.8– C**

**100 Pin 32, 36, or 40 BIT DRAM, 32 BIT SDRAM DIMM PINOUT**

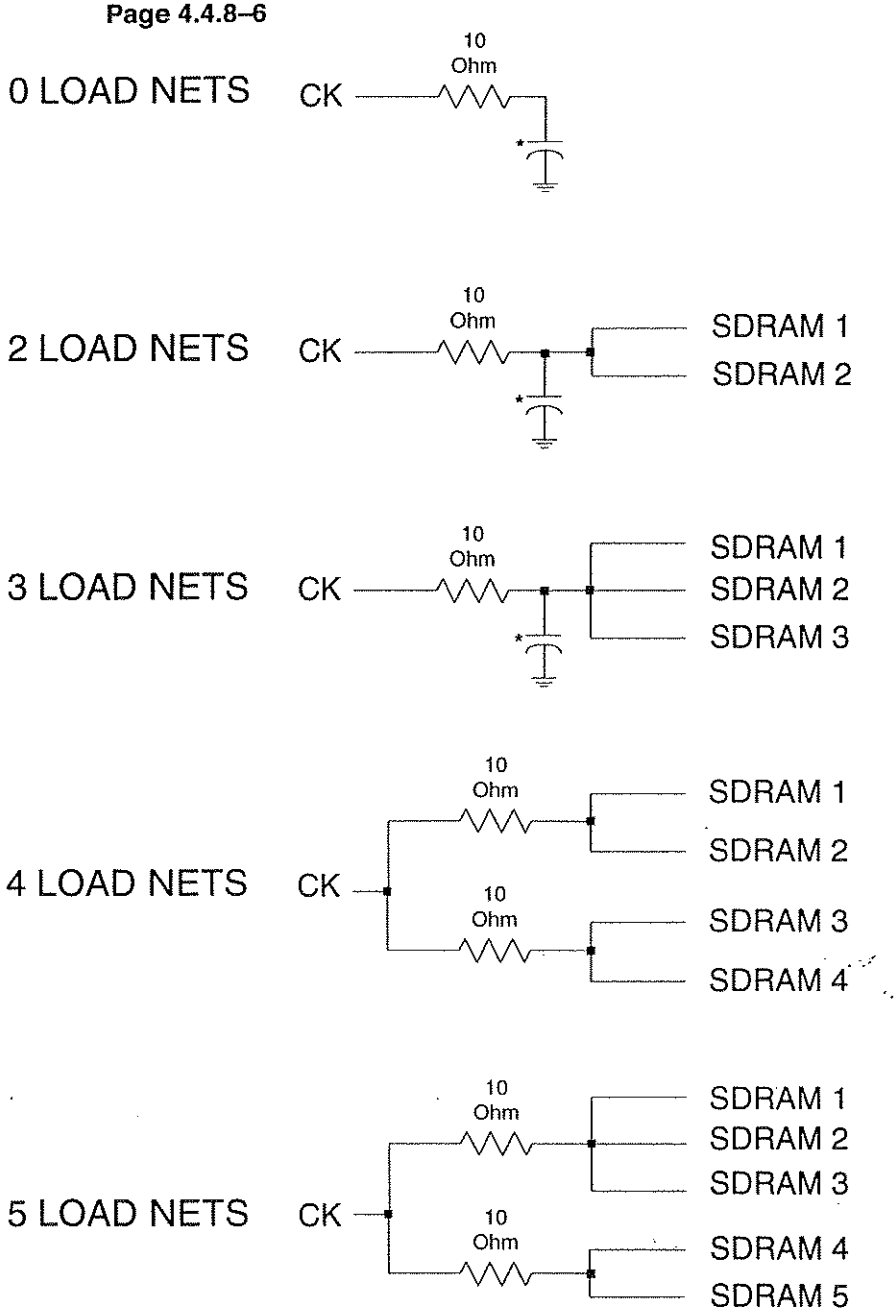
## 100 PIN DRAM/SDRAM DIMM PINOUT COMPARISON

| PIN | DRAM DIMM | SDRAM DIMM | MUX ROM |
|---|---|---|---|
| 11 | $\overline{CAS0}$ | DQMB0 | NU |
| 18 | A10 | A10/AP | A10 |
| 19 | A12 | BA1 | A12 |
| 20 | NU | A12 | A14 |
| 22 | NU | Vref | NU |
| 25 | NU | CK0 | NU |
| 27 | NU | CKE0 | NU |
| 28 | $\overline{WE}$ | $\overline{WE}$ | NU |
| 29 | $\overline{RAS0}$ | $\overline{S0}$ | $\overline{E0}$ |
| 30 | $\overline{RAS2}$ | $\overline{S2}$ | $\overline{E2}$ |
| 37 | $\overline{CAS2}$ | DQMB2 | NU |
| 61 | $\overline{CAS1}$ | DQMB1 | NU |
| 68 | A11 | BA0 | A11 |
| 69 | A13 | A11 | A13 |
| 70 | NU | A13 | A15 |
| 72 | NU | $\overline{RAS}$ | NU |
| 73 | NU | $\overline{CAS}$ | NU |
| 75 | NU | CK1 | NU |
| 77 | NU | CKE1 | NU |
| 78 | $\overline{OE}$ | NU | $\overline{OE}$ |
| 79 | $\overline{RAS1}$ | $\overline{S1}$ | $\overline{E1}$ |
| 80 | $\overline{RAS3}$ | $\overline{S3}$ | $\overline{E3}$ |
| 87 | $\overline{CAS3}$ | DQMB3 | NU |

Notes:

1. A10 on DRAM DIMM is also AP on SDRAM DIMM
2. A14 on DRAM DIMM is also BA0 on SDRAM DIMM
3. A15 on DRAM DIMM is also BA1 on SDRAM DIMM (for 4 Bank SDRAM).

**Figure 4.4.8–D**
**100 Pin DRAM, SDRAM, & ROM DIMM, PIN COMPARISON**

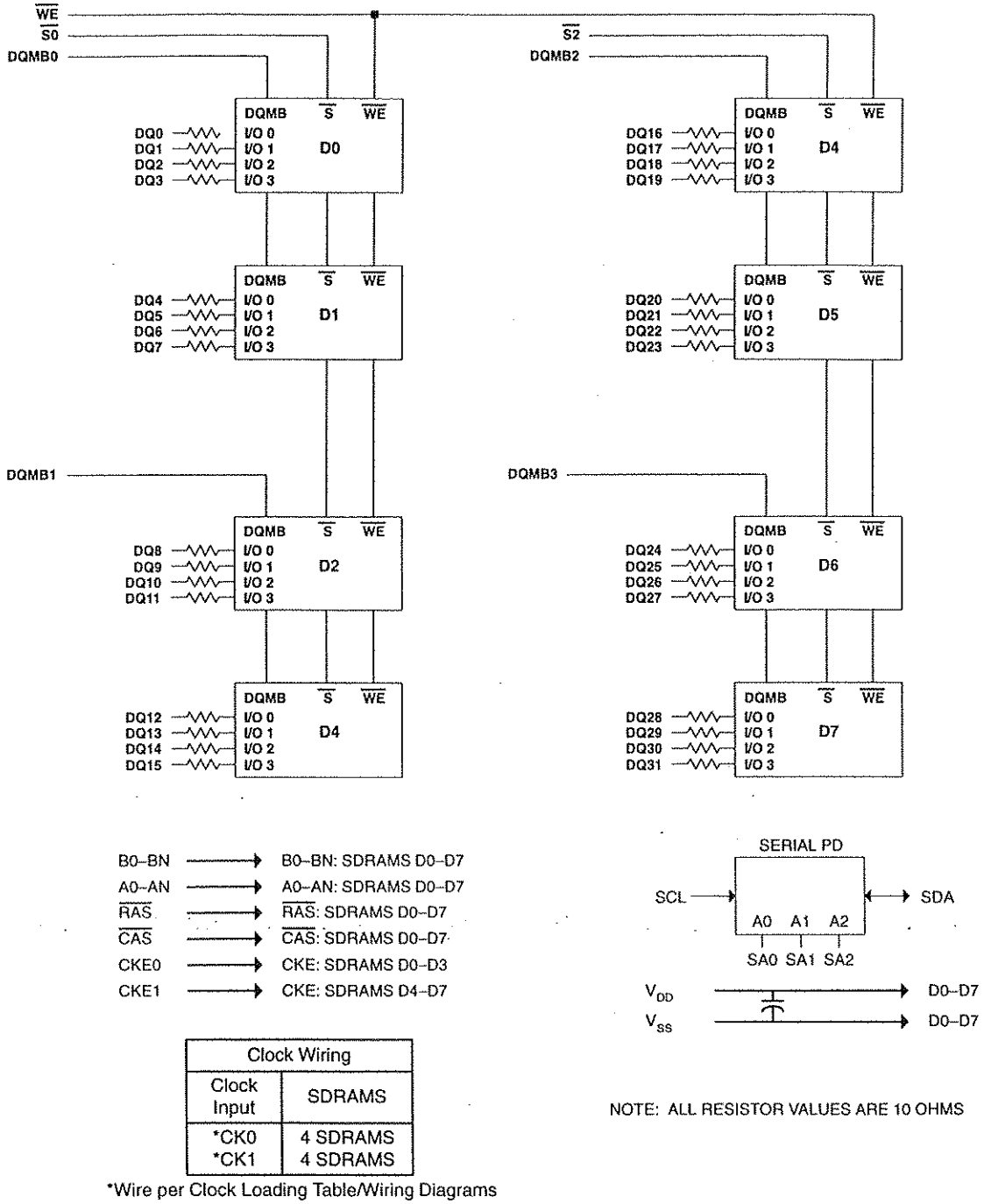



Notes:

1. THE CK INPUTS SHOULD HAVE A NOMINAL DELAY OF .4ns MEASURED FROM THE CK INPUT AT THE DIMM TAB TO THE CK INPUT OF THE SDRAM (OR PADDING CAPACITOR). (EG: THIS IS APPROXIMATELY 2" OF PCB WIRE AND 2.5pf OF INPUT CAPACITANCE).

2.) THE VARIATION OF CK INPUT DELAY WILL BE +/– .1NS FOR BOTH CK INPUTS. (EG: IF THE WIRE IMPEDANCE IS APPROX. 65 ohms, THIS CORRESPONDS TO A CAPACITANCE VARIATION OF +/– 3pf IN TOTAL CK INPUT CAPACITANCE).

**Figure 4.4.8–E**
**100 Pin SDRAM DIMM, CLOCK WIRING**




| Clock Wiring | |
|---|---|
| Clock Input | SDRAMS |
| *CK0 | 4 SDRAMS |
| *CK1 | 4 SDRAMS |

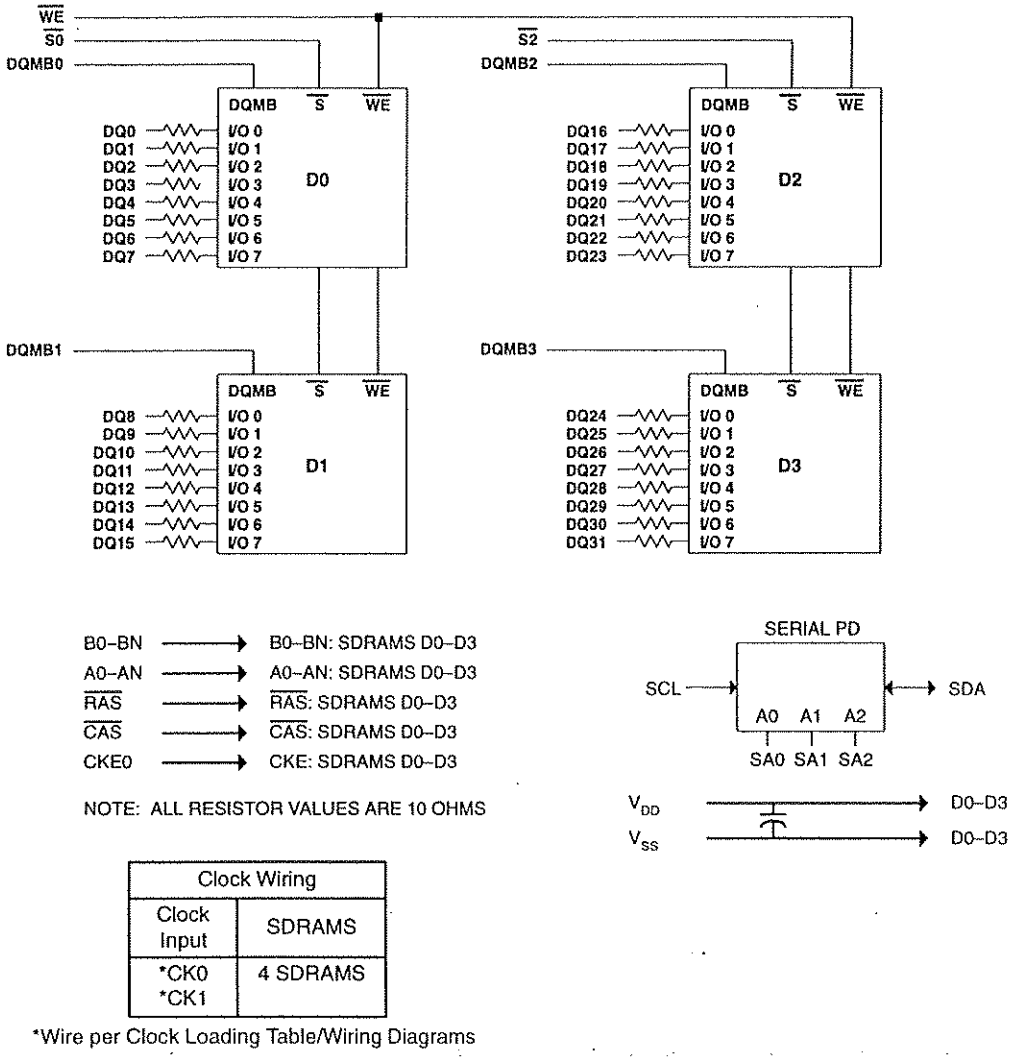
*Wire per Clock Loading Table/Wiring Diagrams

NOTE: ALL RESISTOR VALUES ARE 10 OHMS

## Figure 4.4.8–F
## 100 Pin X32 SDRAM DIMM, 1 Bank with X4 SDRAMs



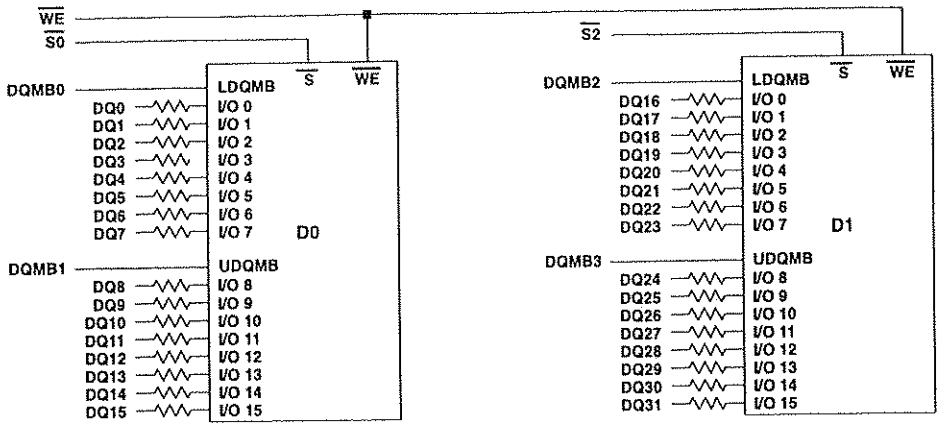
XILINX EXHIBIT 1012
Page 287

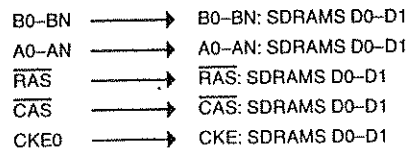



| Clock Wiring | |
|---|---|
| Clock Input | SDRAMS |
| *CK0<br>*CK1 | 4 SDRAMS |

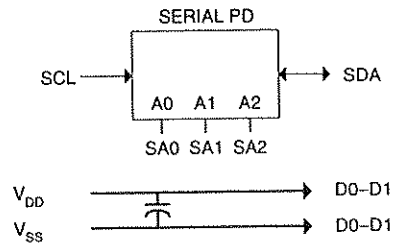
*Wire per Clock Loading Table/Wiring Diagrams

## Figure 4.4.8–G
## 100 Pin X32 SDRAM DIMM, 1 Bank with X8 SDRAMs



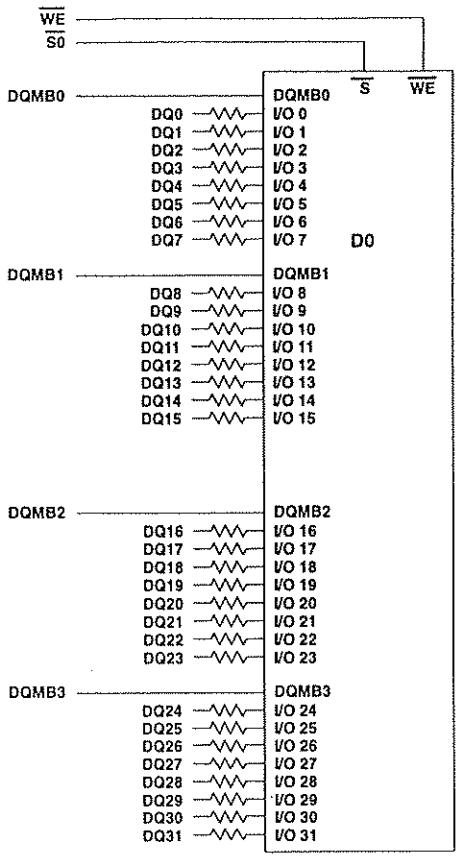

NOTE: ALL RESISTOR VALUES ARE 10 OHMS




| Clock Wiring | |
|---|---|
| Clock Input | SDRAMS |
| *CK0<br>*CK1 | 2 SDRAMS |

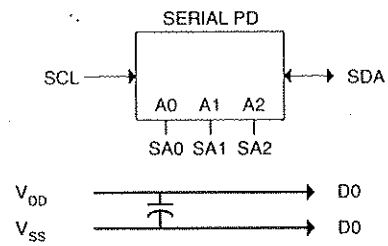
*Wire per Clock Loading Table/Wiring Diagrams

## Figure 4.4.8–H
## 100 Pin X32 SDRAM DIMM, 1 Bank with X16 SDRAMs




B0–BN → B0–BN: SDRAMS D0
A0–AN → A0–AN: SDRAMS D0
$\overline{RAS}$ → $\overline{RAS}$: SDRAMS D0
$\overline{CAS}$ → $\overline{CAS}$: SDRAMS D0
CKE0 → CKE: SDRAMS D0

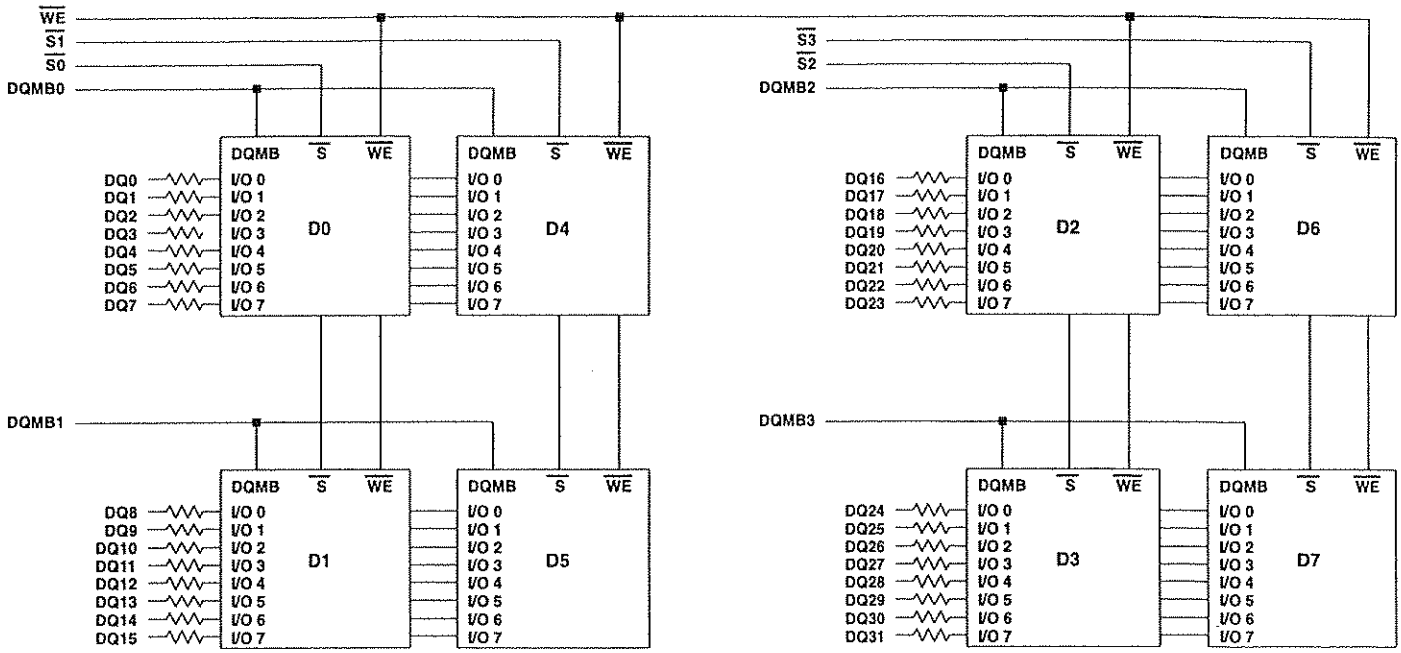
NOTE: ALL RESISTOR VALUES ARE 10 OHMS




| Clock Wiring | |
|---|---|
| Clock Input | SDRAMS |
| *CK0<br>*CK1 | 1 SDRAMS |

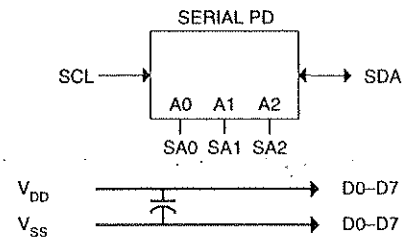
*Wire per Clock Loading Table/Wiring Diagrams

## Figure 4.4.8–I
## 100 Pin X32 SDRAM DIMM, 1 Bank with X32 SDRAMs




B0–BN → B0–BN: SDRAMS D0–D7
A0–AN → A0–AN: SDRAMS D0–D7
$\overline{RAS}$ → $\overline{RAS}$: SDRAMS D0–D7
$\overline{CAS}$ → $\overline{CAS}$: SDRAMS D0–D7
CKE0 → CKE: SDRAMS D0–D3
CKE1 → CKE: SDRAMS D4–D7

NOTE: ALL RESISTOR VALUES ARE 10 OHMS

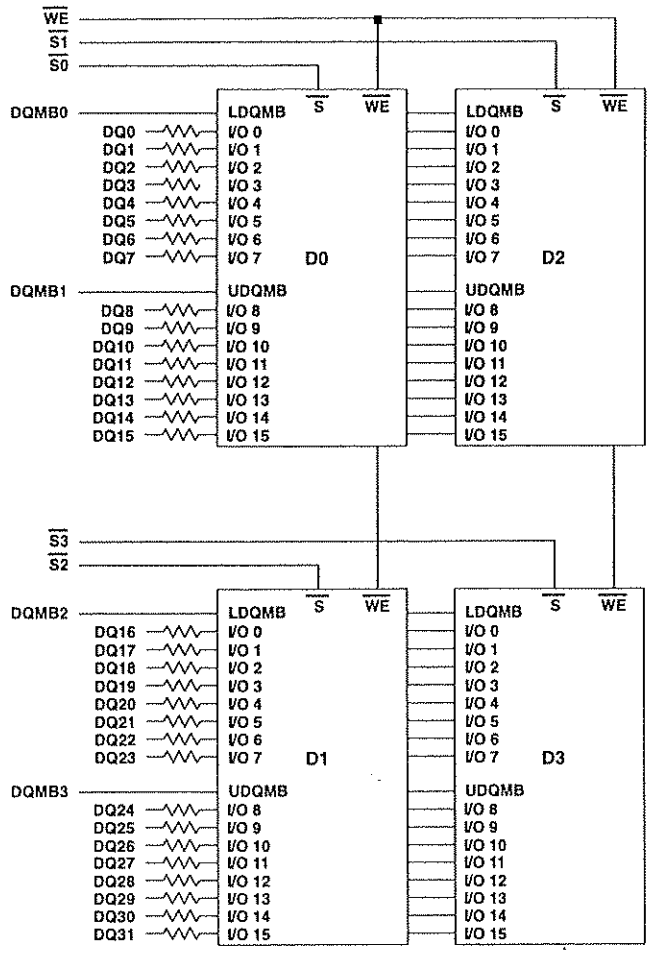



| Clock Wiring | |
|---|---|
| Clock Input | SDRAMS |
| *CK0 | 4 SDRAMS |
| *CK1 | 4 SDRAMS |

*Wire per Clock Loading Table/Wiring Diagrams

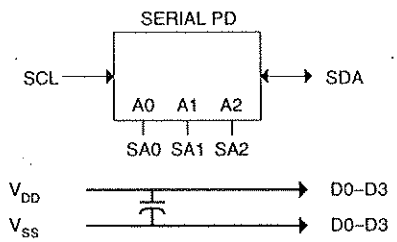
## Figure 4.4.8–J
## 100 Pin X32 SDRAM DIMM, 2 Bank with X8 SDRAMs

4.4.6–1




B0–BN → B0–BN: SDRAMS D0–D3
A0–AN → A0–AN: SDRAMS D0–D3
$\overline{RAS}$ → $\overline{RAS}$: SDRAMS D0–D3
$\overline{CAS}$ → $\overline{CAS}$: SDRAMS D0–D3
CKE0 → CKE: SDRAMS D0–D1
CKE1 → CKE: SDRAMS D2–D3

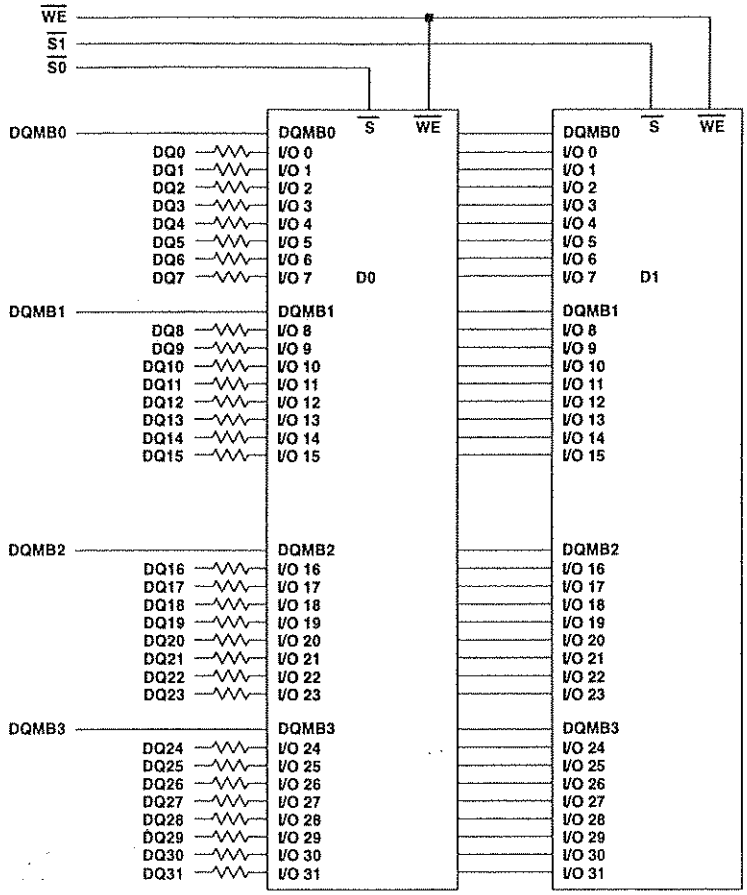
NOTE: ALL RESISTOR VALUES ARE 10 OHMS




| Clock Wiring | |
|---|---|
| Clock Input | SDRAMS |
| *CK0 | 2 SDRAMS |
| *CK1 | 2 SDRAMS |

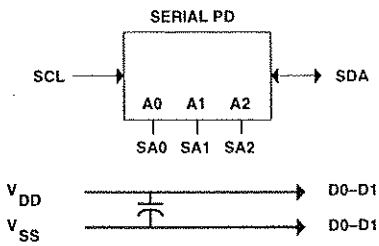
*Wire per Clock Loading Table/Wiring Diagrams

## Figure 4.4.8–K
## 100 Pin X32 SDRAM DIMM, 2 Bank with X16 SDRAMs




B0–BN → B0–BN: SDRAMS D0–D1
A0–AN → A0–AN: SDRAMS D0–D1
$\overline{RAS}$ → $\overline{RAS}$: SDRAMS D0–D1
$\overline{CAS}$ → $\overline{CAS}$: SDRAMS D0–D1
CKE0 → CKE: SDRAMS D0
CKE1 → CKE: SDRAMS D1

NOTE: ALL RESISTOR VALUES ARE 10 OHMS



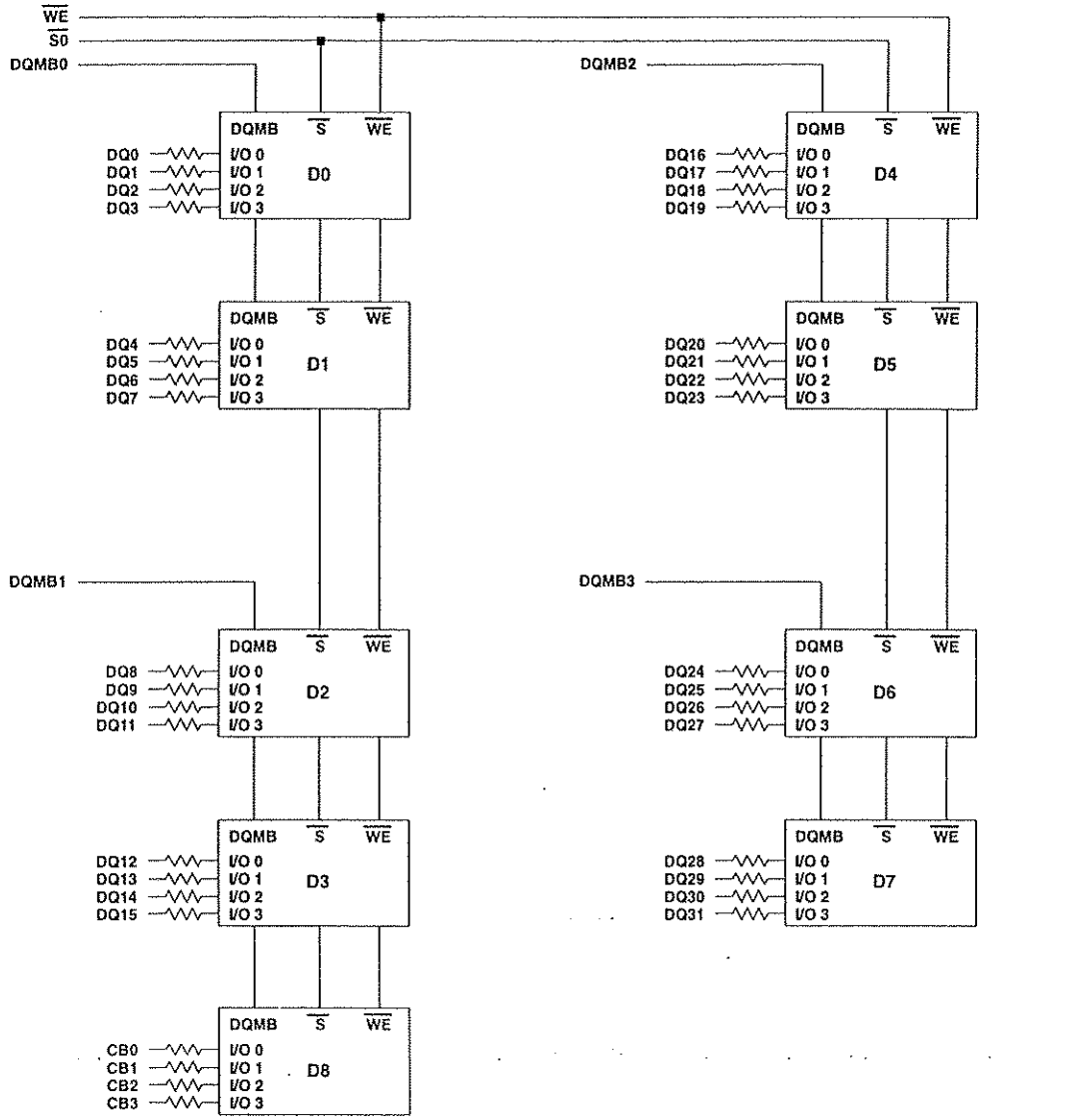

| Clock Wiring | |
|---|---|
| Clock Input | SDRAMS |
| *CK0 | 1 SDRAM |
| *CK1 | 1 SDRAM |

*Wire per Clock Loading Table/Wiring Diagrams

## Figure 4.4.8–L
## 100 Pin X32 SDRAM DIMM, 2 Bank with X32 SDRAMs



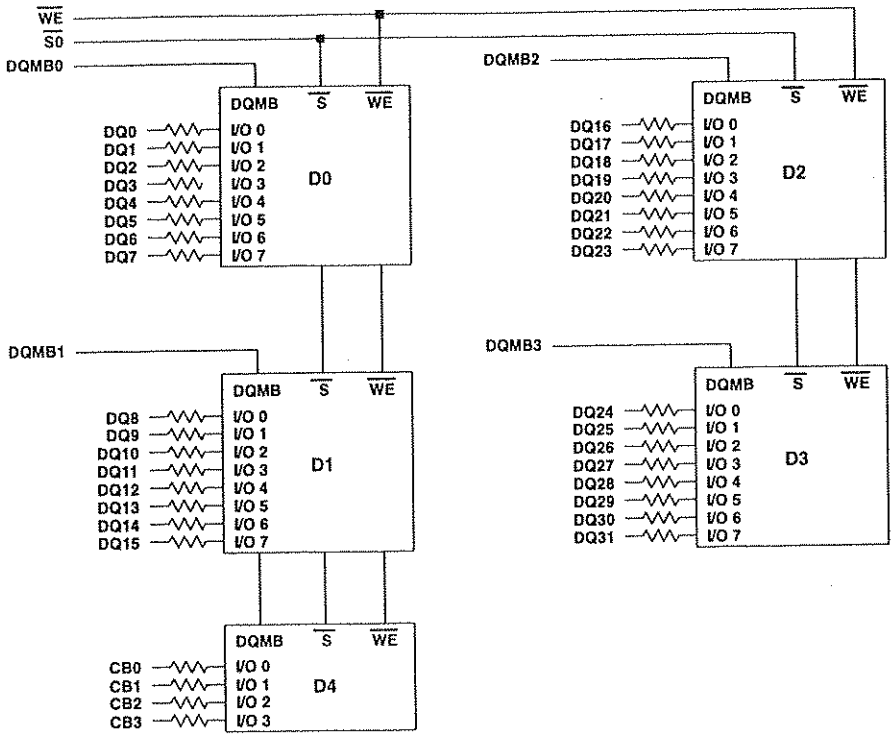
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Page 293




| Clock Wiring | |
|---|---|
| Clock Input | SDRAMS |
| *CK0 | 4 or 5 SDRAMS |
| *CK1 | 4 or 5 SDRAMS |

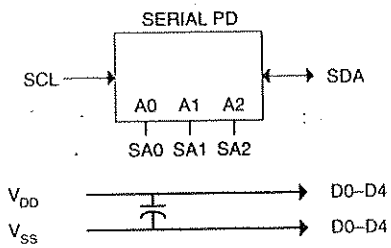
*Wire per Clock Loading Table/Wiring Diagrams

## Figure 4.4.8–M
## 100 Pin X36 ECC SDRAM DIMM, 1 Bank with X4 SDRAMs




B0–BN → B0–BN: SDRAMS D0–D4
A0–AN → A0–AN: SDRAMS D0–D4
$\overline{RAS}$ → $\overline{RAS}$: SDRAMS D0–D4
$\overline{CAS}$ → $\overline{CAS}$: SDRAMS D0–D4
CKE0 → CKE: SDRAMS D0–D4

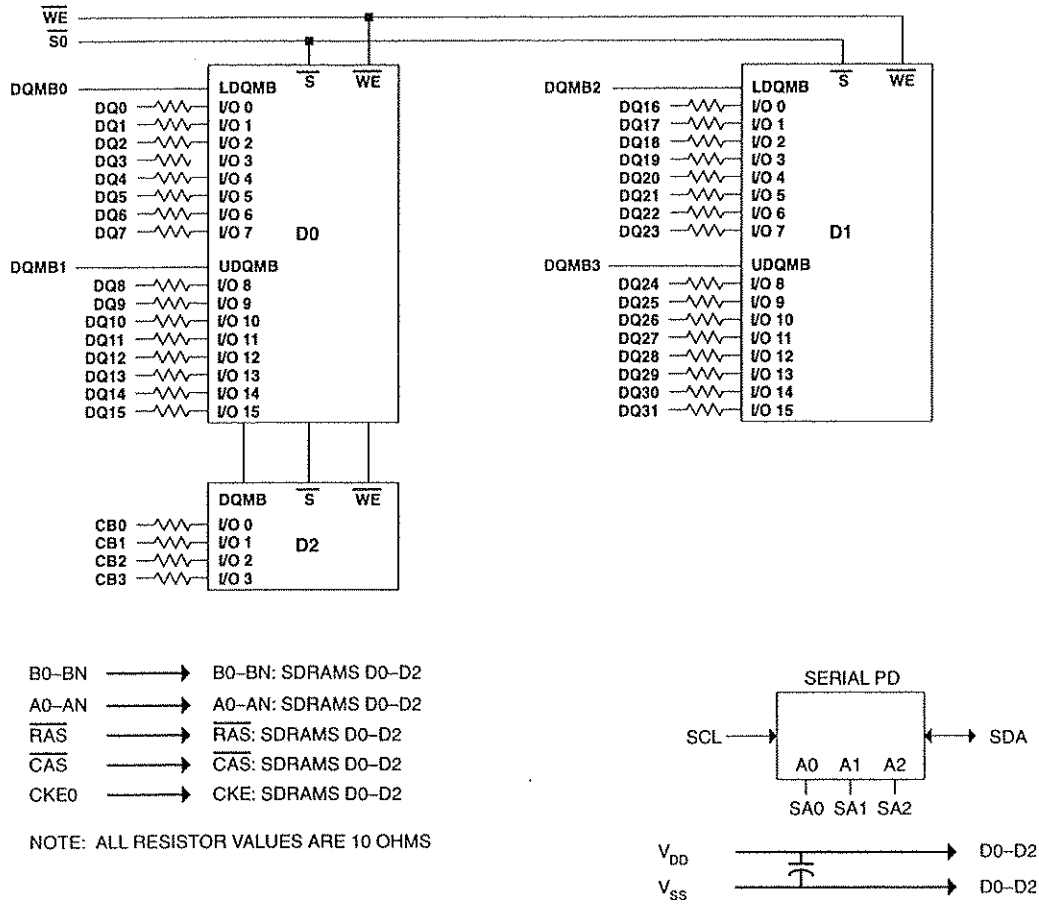
NOTE: ALL RESISTOR VALUES ARE 10 OHMS




| Clock Wiring | |
|---|---|
| Clock Input | SDRAMS |
| *CK0<br>*CK1 | 5 SDRAMS |

*Wire per Clock Loading Table/Wiring Diagrams

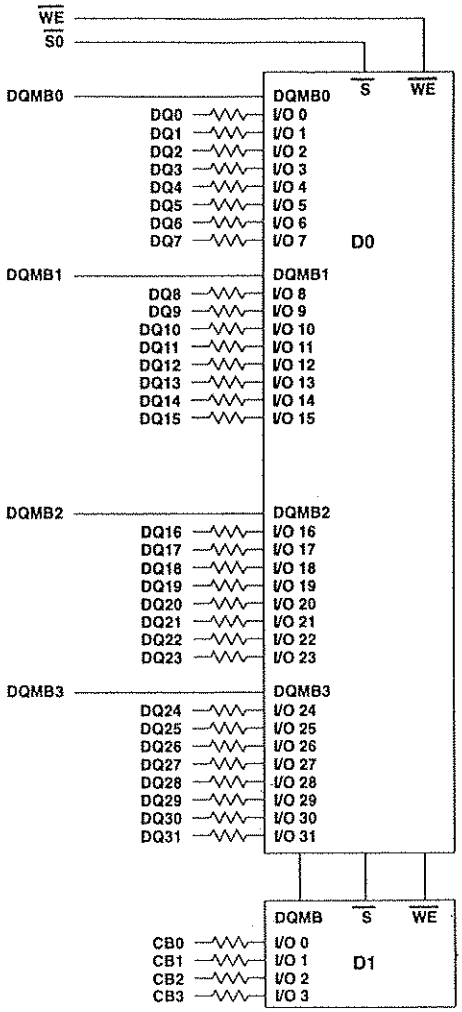
## Figure 4.4.8–N
## 100 Pin X36 ECC SDRAM DIMM, 1 Bank with X4 & X8 SDRAMs




| Clock Wiring | |
|---|---|
| Clock Input | SDRAMS |
| *CK0<br>*CK1 | 3 SDRAMS |

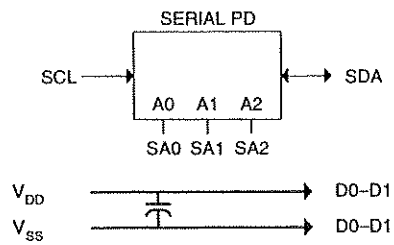
*Wire per Clock Loading Table/Wiring Diagrams

## Figure 4.4.8–O
## 100 Pin X36 ECC SDRAM DIMM, 1 Bank with X4 & X16 SDRAMs




B0–BN → B0–BN: SDRAMS D0–D1
A0–AN → A0–AN: SDRAMS D0–D1
$\overline{RAS}$ → $\overline{RAS}$: SDRAMS D0–D1
$\overline{CAS}$ → $\overline{CAS}$: SDRAMS D0–D1
CKE0 → CKE: SDRAMS D0–D1

NOTE: ALL RESISTOR VALUES ARE 10 OHMS

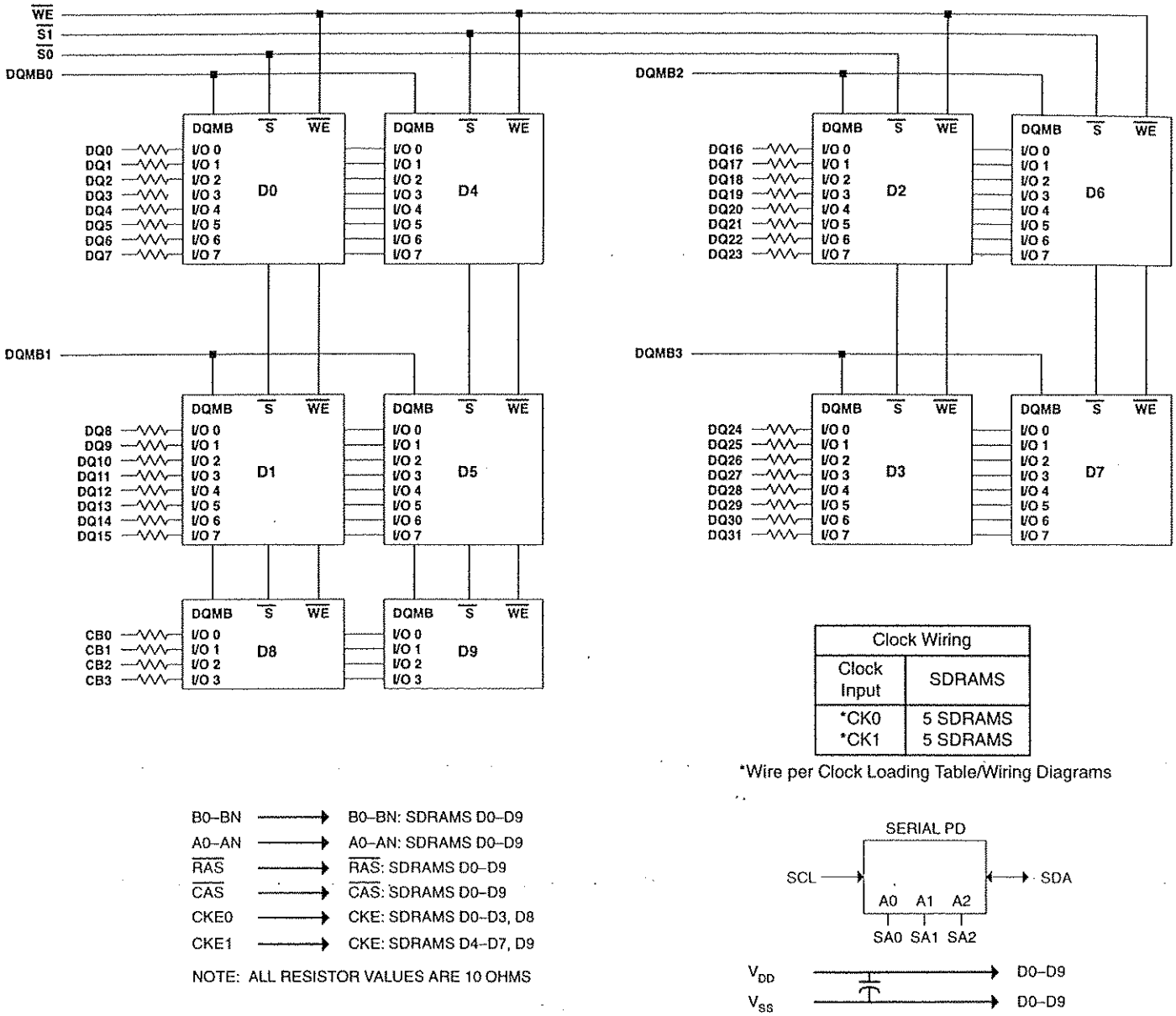



| Clock Wiring | |
|---|---|
| Clock Input | SDRAMS |
| *CK0<br>*CK1 | 2 SDRAMS |

*Wire per Clock Loading Table/Wiring Diagrams

## Figure 4.4.8–P
## 100 Pin X36 ECC SDRAM DIMM, 1 Bank with X4 & X32 SDRAMs

Release 7




| Clock Wiring | |
|---|---|
| Clock Input | SDRAMS |
| *CK0 | 5 SDRAMS |
| *CK1 | 5 SDRAMS |

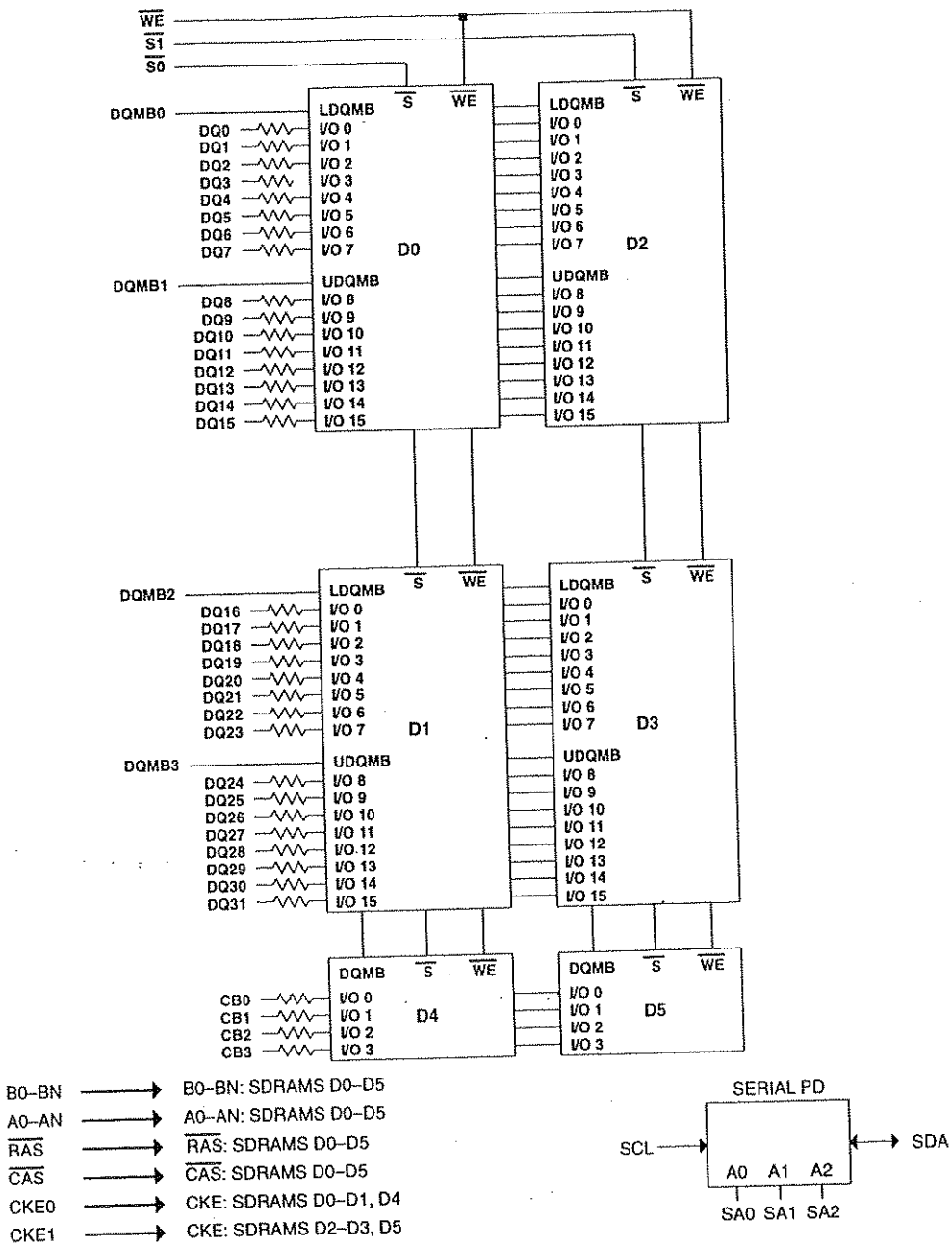
*Wire per Clock Loading Table/Wiring Diagrams

B0–BN → B0–BN: SDRAMS D0–D9
A0–AN → A0–AN: SDRAMS D0–D9
$\overline{RAS}$ → $\overline{RAS}$: SDRAMS D0–D9
$\overline{CAS}$ → $\overline{CAS}$: SDRAMS D0–D9
CKE0 → CKE: SDRAMS D0–D3, D8
CKE1 → CKE: SDRAMS D4–D7, D9

NOTE: ALL RESISTOR VALUES ARE 10 OHMS




## Figure 4.4.8–Q
## 100 Pin X36 ECC SDRAM DIMM, 2 Bank with X4 & X8 SDRAMs

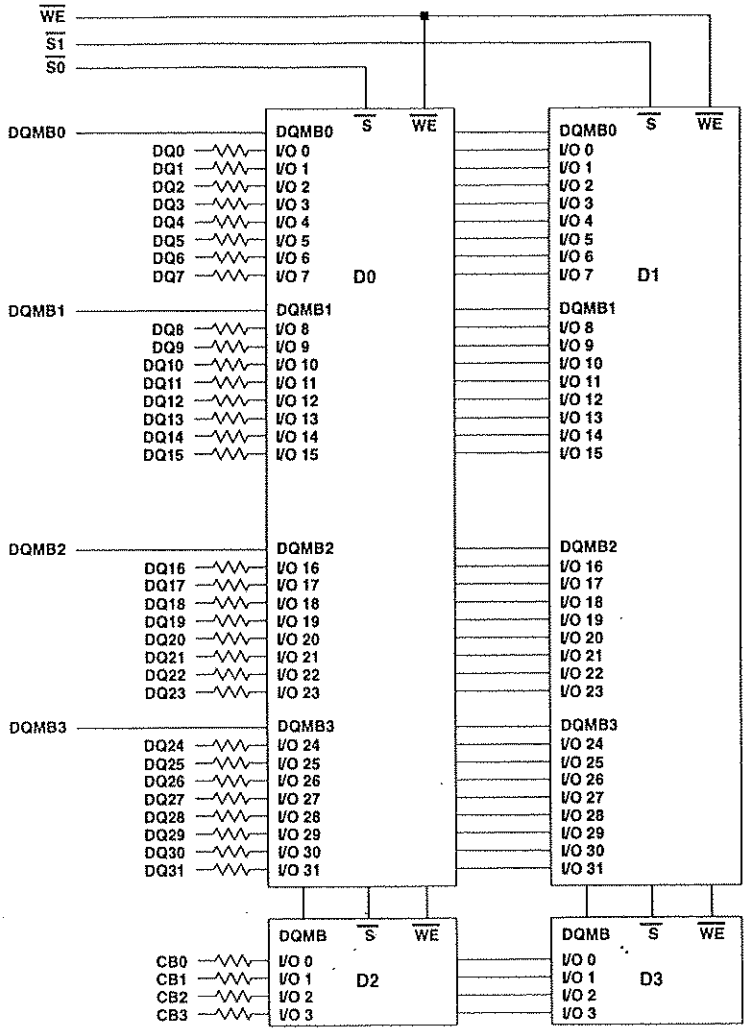



| Clock Wiring | |
|---|---|
| Clock Input | SDRAMS |
| *CK0 | 3 SDRAMS |
| *CK1 | 3 SDRAMS |

*Wire per Clock Loading Table/Wiring Diagrams

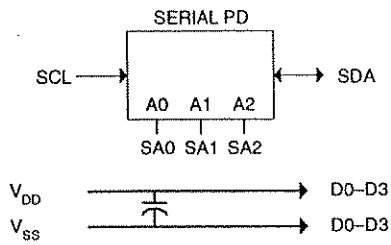
## Figure 4.4.8–R
## 100 Pin X36 ECC SDRAM DIMM, 2 Bank with X4 & X16 SDRAMs

Release 7




B0–BN ⟶ B0–BN: SDRAMS D0–D3
A0–AN ⟶ A0–AN: SDRAMS D0–D3
$\overline{RAS}$ ⟶ $\overline{RAS}$: SDRAMS D0–D3
$\overline{CAS}$ ⟶ $\overline{CAS}$: SDRAMS D0–D3
CKE0 ⟶ CKE: SDRAMS D0, D2
CKE1 ⟶ CKE: SDRAMS D1, D3

NOTE: ALL RESISTOR VALUES ARE 10 OHMS

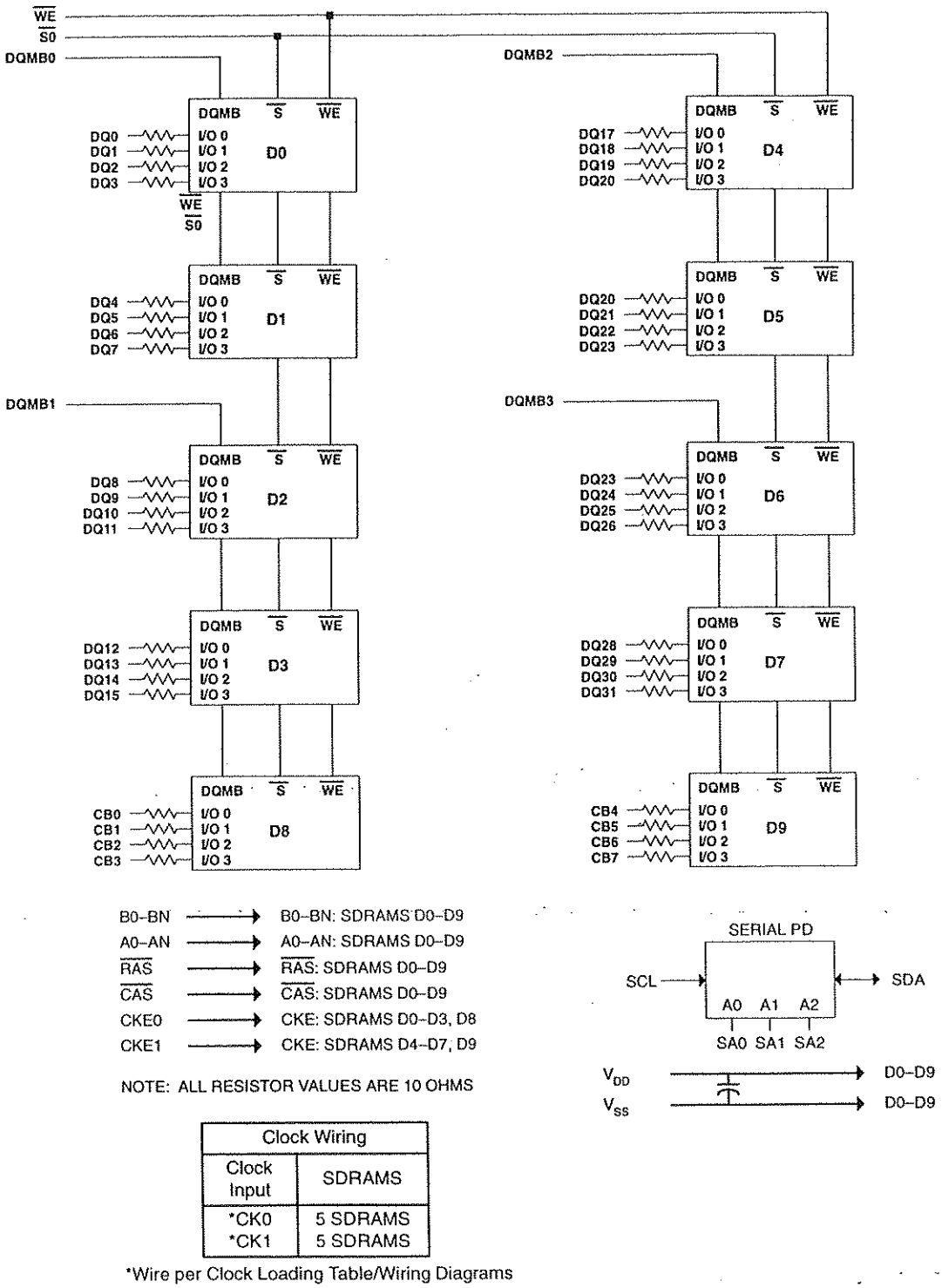



| Clock Wiring | |
|---|---|
| Clock Input | SDRAMS |
| *CK0 | 2 SDRAMS |
| *CK1 | 2 SDRAMS |

*Wire per Clock Loading Table/Wiring Diagrams

## Figure 4.4.8–S
## 100 Pin X36 ECC SDRAM DIMM, 2 Bank with X4 & X32 SDRAMs

Release 7



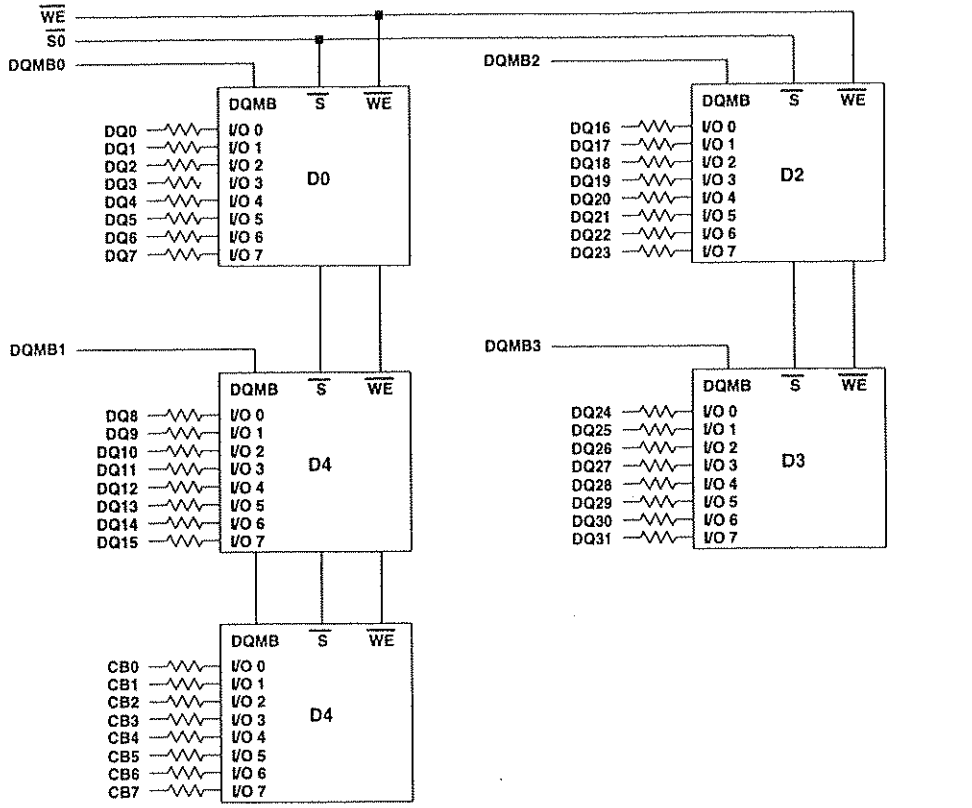

NOTE: ALL RESISTOR VALUES ARE 10 OHMS

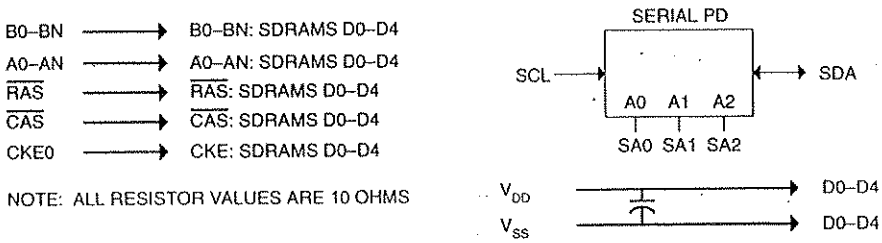
| Clock Wiring | |
|---|---|
| Clock Input | SDRAMS |
| *CK0 | 5 SDRAMS |
| *CK1 | 5 SDRAMS |

*Wire per Clock Loading Table/Wiring Diagrams

## Figure 4.4.8–T
## 100 Pin X40 ECC SDRAM DIMM, 1 Bank with X4 SDRAMs

Release 7



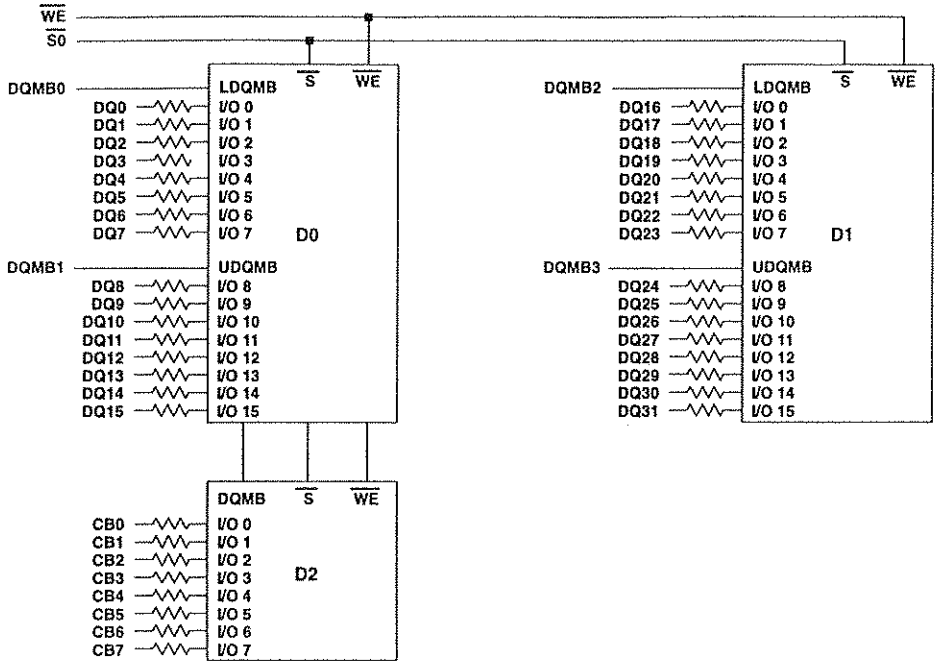



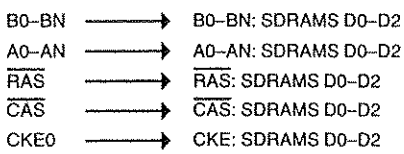

NOTE: ALL RESISTOR VALUES ARE 10 OHMS

| Clock Wiring | |
|---|---|
| Clock Input | SDRAMS |
| *CK0<br>*CK1 | 5 SDRAMS |

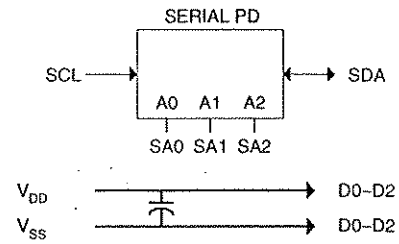
*Wire per Clock Loading Table/Wiring Diagrams

## Figure 4.4.8–U
## 100 Pin X40 ECC SDRAM DIMM, 1 Bank with X8 SDRAMs



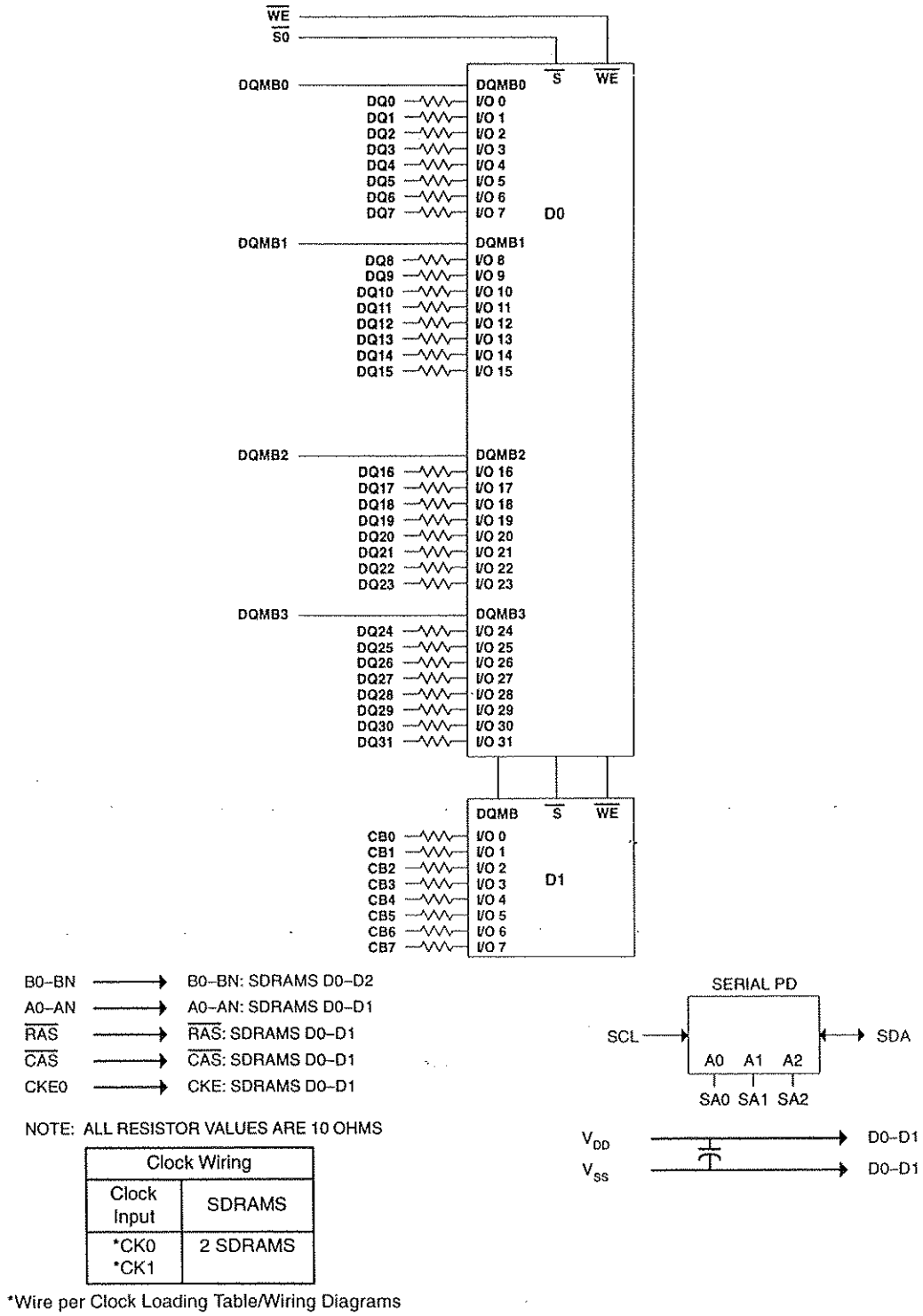

NOTE: ALL RESISTOR VALUES ARE 10 OHMS




| Clock Wiring | |
|---|---|
| Clock Input | SDRAMS |
| *CK0<br>*CK1 | 3 SDRAMS |

*Wire per Clock Loading Table/Wiring Diagrams

## Figure 4.4.8–V
## 100 Pin X40 ECC SDRAM DIMM, 1 Bank with X8 & X16 SDRAMs



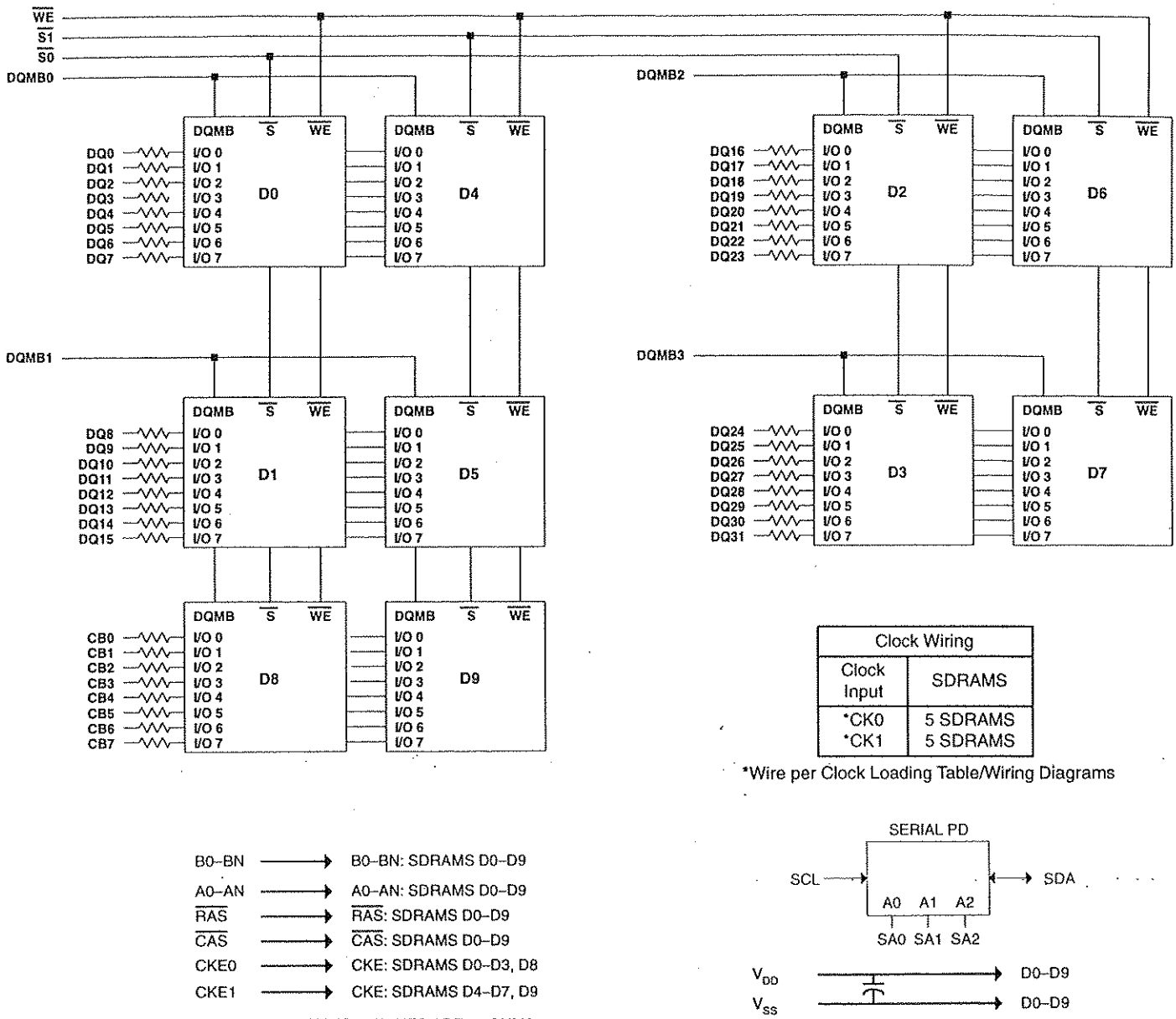

NOTE: ALL RESISTOR VALUES ARE 10 OHMS

| Clock Wiring | |
|---|---|
| Clock Input | SDRAMS |
| *CK0<br>*CK1 | 2 SDRAMS |

*Wire per Clock Loading Table/Wiring Diagrams

## Figure 4.4.8–W
## 100 Pin X40 ECC SDRAM DIMM, 1 Bank with X8 & X32 SDRAMs

Release 7




| Clock Wiring | |
|---|---|
| Clock Input | SDRAMS |
| *CK0 | 5 SDRAMS |
| *CK1 | 5 SDRAMS |

*Wire per Clock Loading Table/Wiring Diagrams

B0–BN ⟶ B0–BN: SDRAMS D0–D9
A0–AN ⟶ A0–AN: SDRAMS D0–D9
$\overline{RAS}$ ⟶ $\overline{RAS}$: SDRAMS D0–D9
$\overline{CAS}$ ⟶ $\overline{CAS}$: SDRAMS D0–D9
CKE0 ⟶ CKE: SDRAMS D0–D3, D8
CKE1 ⟶ CKE: SDRAMS D4–D7, D9

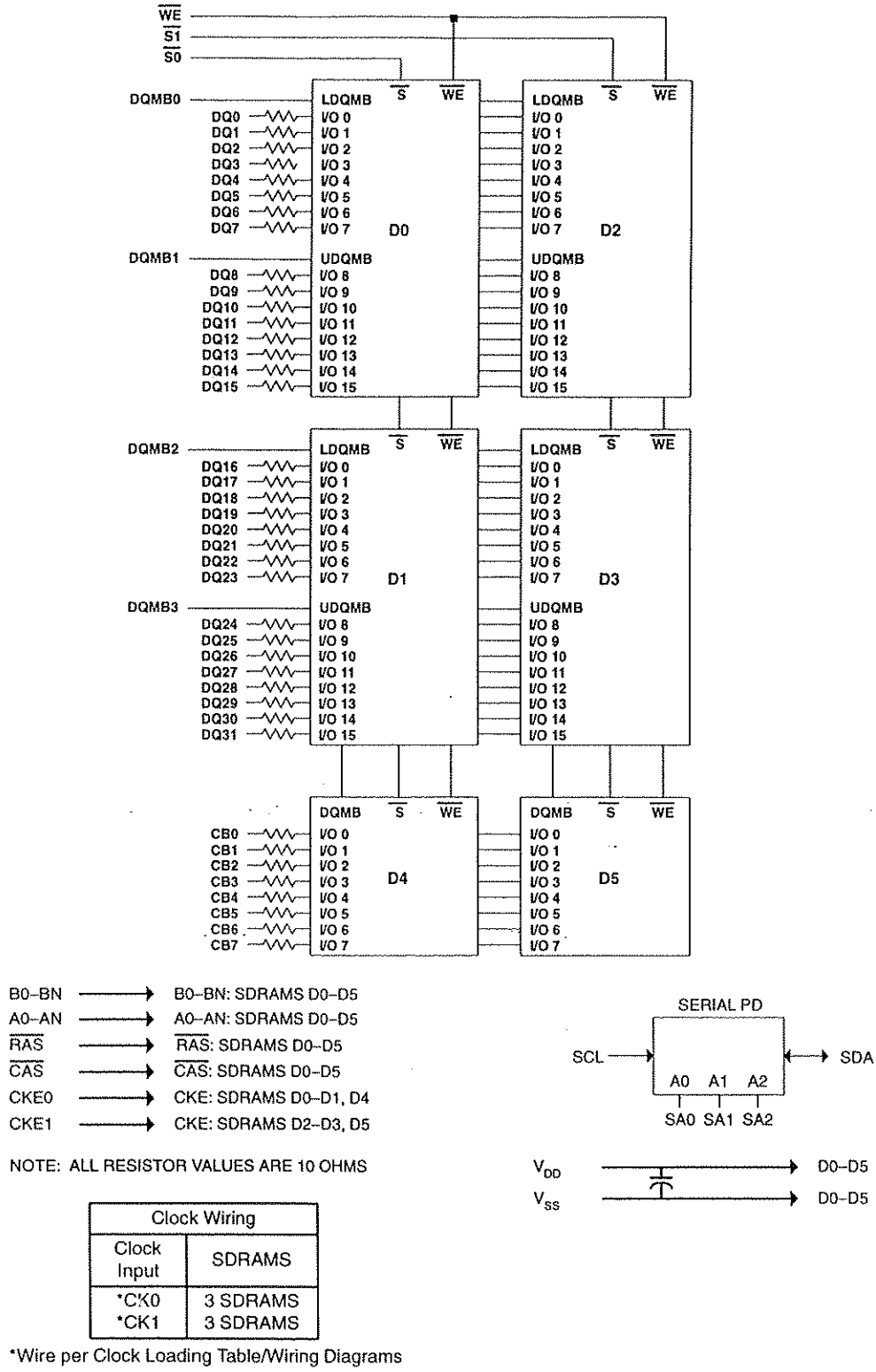
NOTE: ALL RESISTOR VALUES ARE 10 OHMS




## Figure 4.4.8–X
## 100 Pin X40 ECC SDRAM DIMM, 2 Bank with X8 SDRAMs



XILINX EXHIBIT 1012
Page 305

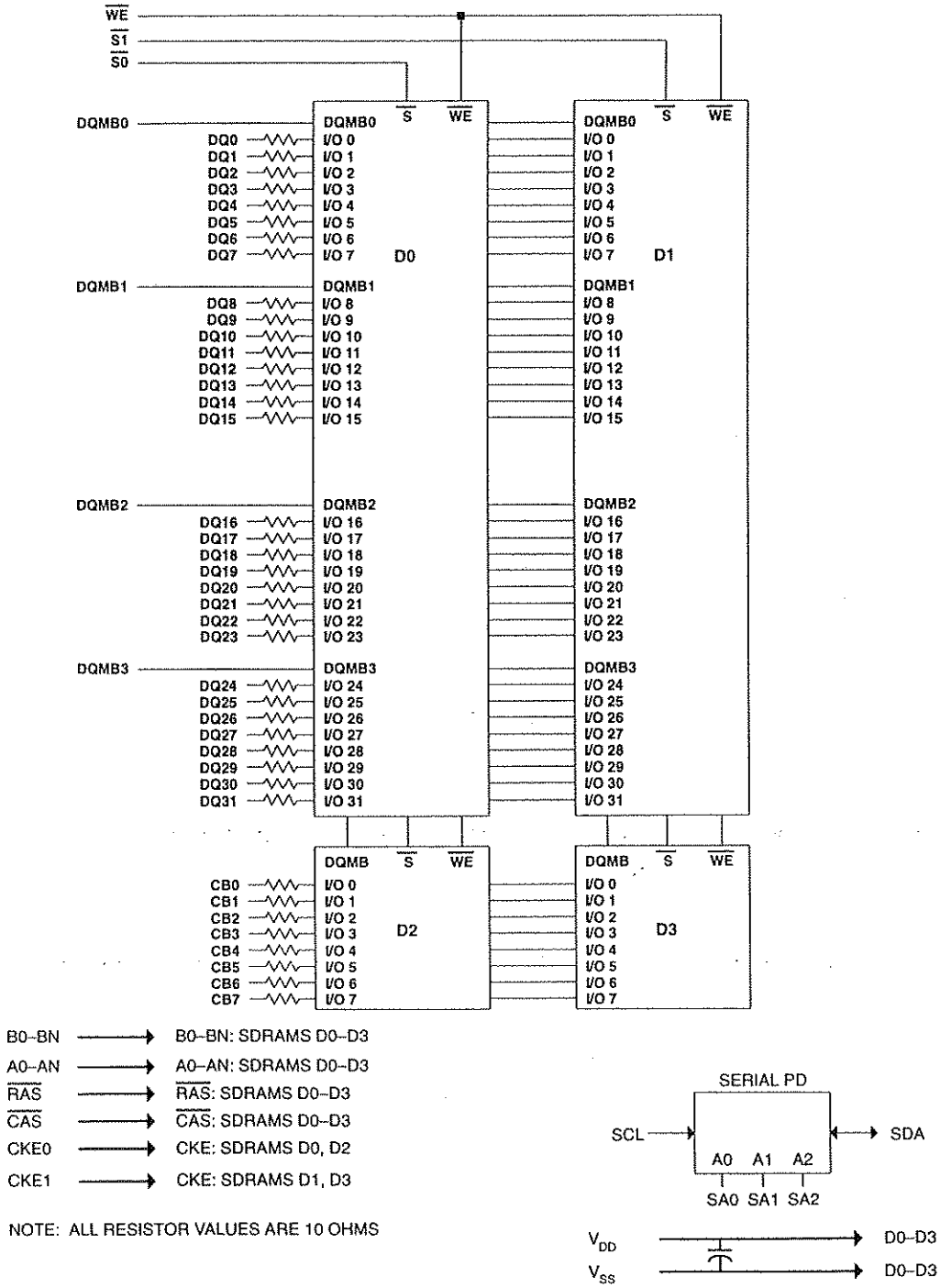



| Clock Wiring | |
|---|---|
| Clock Input | SDRAMS |
| *CK0 | 3 SDRAMS |
| *CK1 | 3 SDRAMS |

*Wire per Clock Loading Table/Wiring Diagrams

## Figure 4.4.8–Y
## 100 Pin X40 ECC SDRAM DIMM, 2 Bank with X8 & X16 SDRAMs

Release 7




| Clock Wiring | |
|---|---|
| Clock Input | SDRAMS |
| *CK0 | 2 SDRAMS |
| *CK1 | 2 SDRAMS |

*Wire per Clock Loading Table/Wiring Diagrams

## Figure 4.4.8–Z
## 100 Pin X40 ECC SDRAM DIMM, 2 Bank with X8 & X32 SDRAMs

Release 7

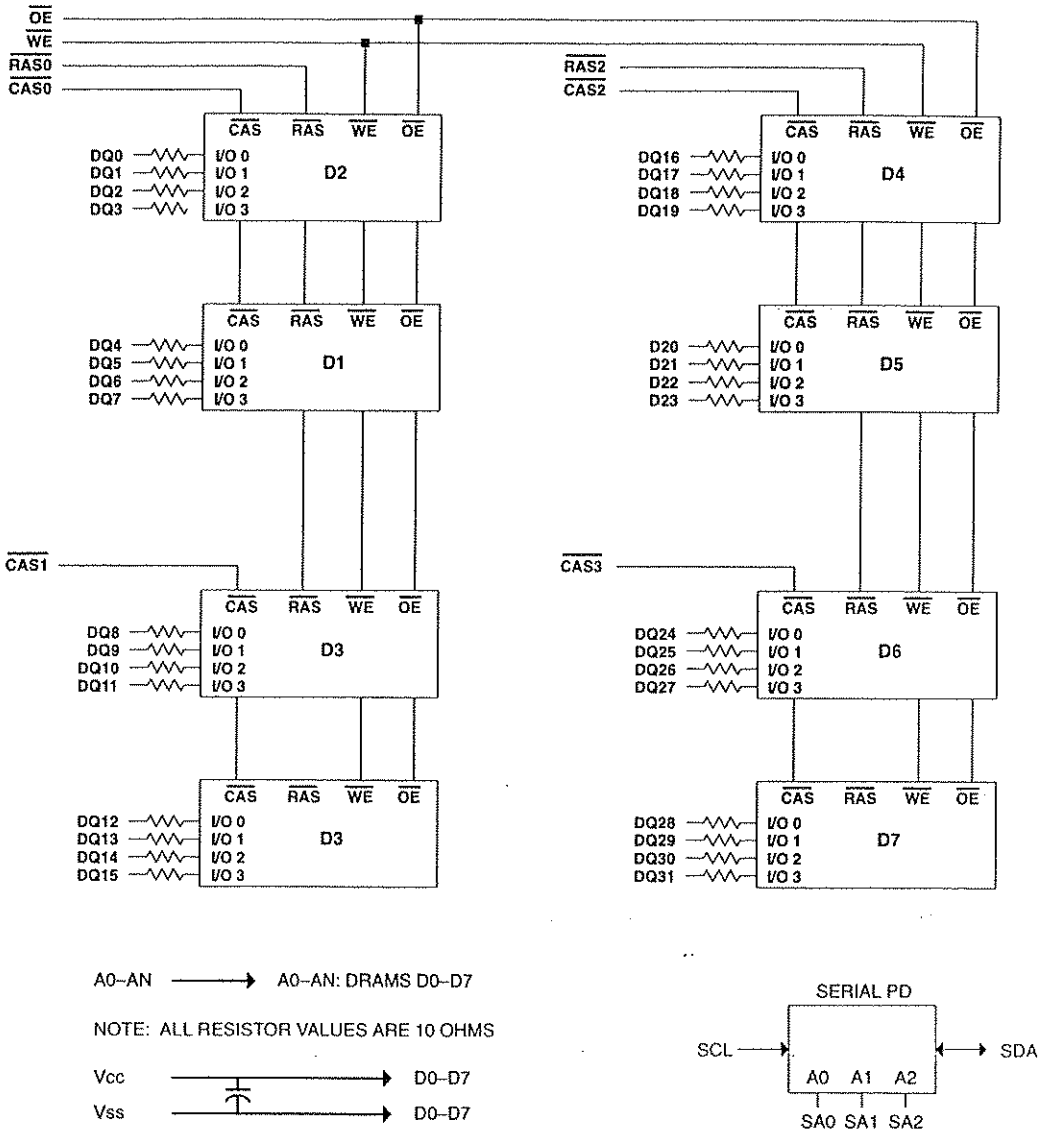



**Figure 4.4.8–AA**
**100 Pin X32 DRAM DIMM, 1 Bank with X4 DRAMs**

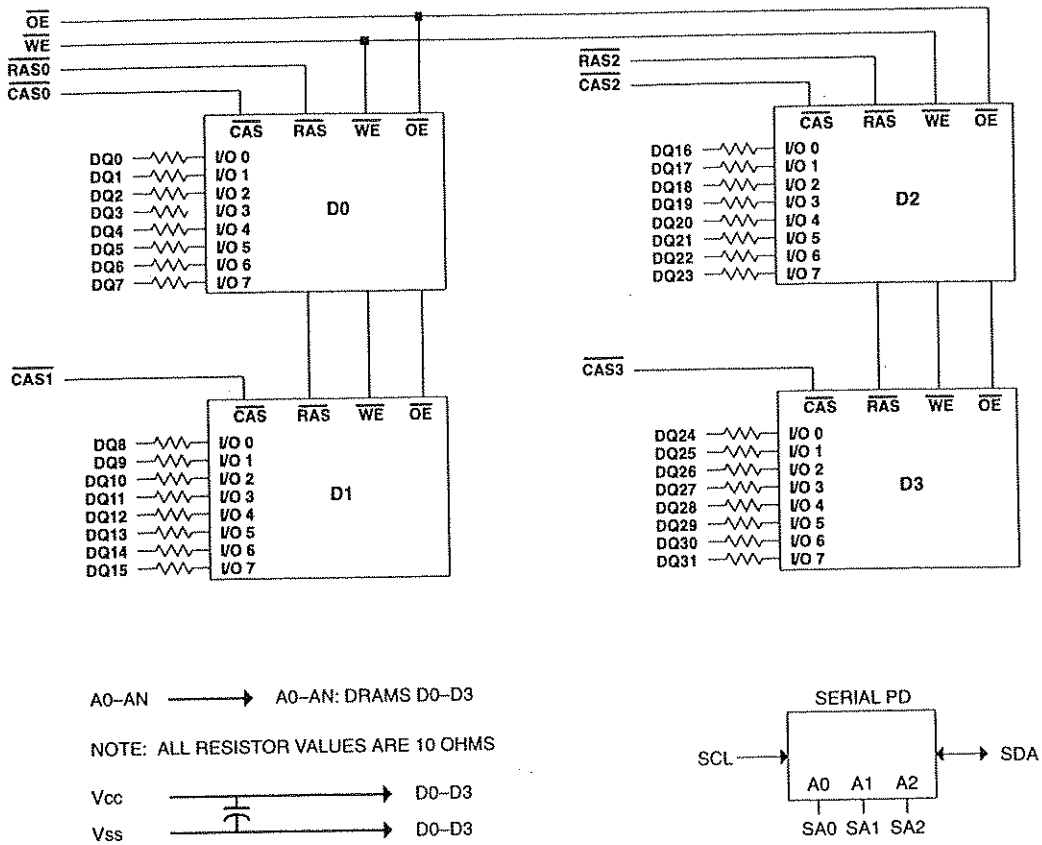
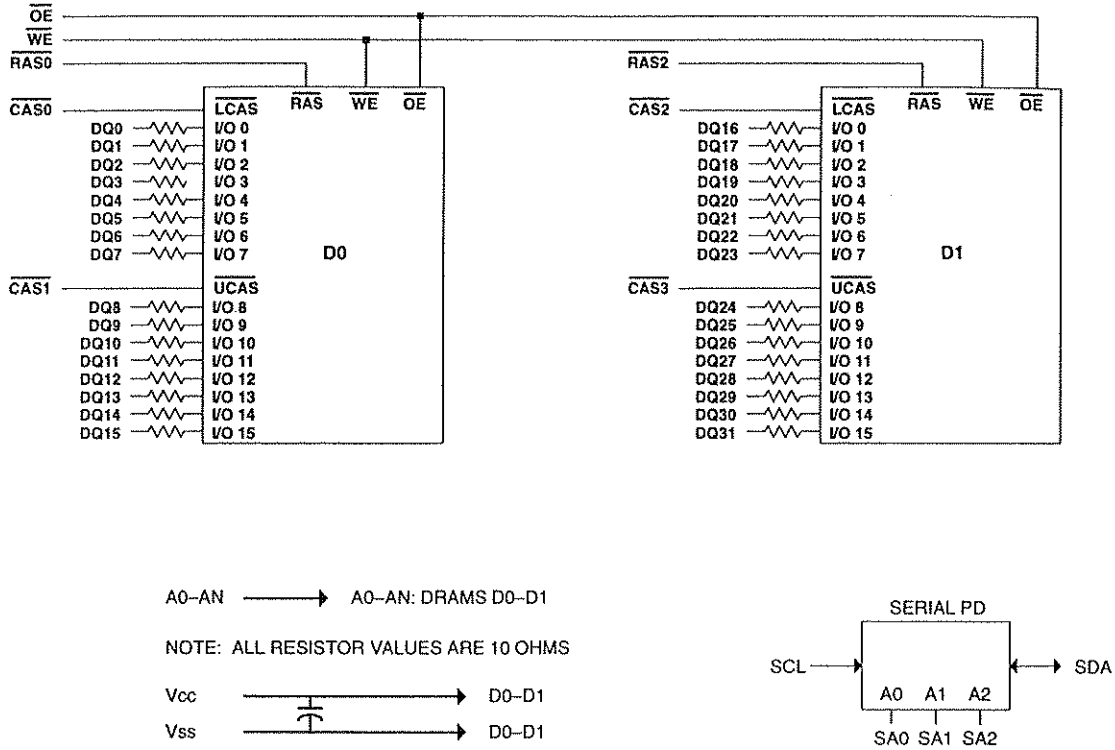



**Figure 4.4.8–AB**
**100 Pin X32 DRAM DIMM, 1 Bank with X8 DRAMs**



XILINX EXHIBIT 1012
Page 309




## Figure 4.4.8–AC
## 100 Pin X32 DRAM DIMM, 1 Bank with X16 DRAMs

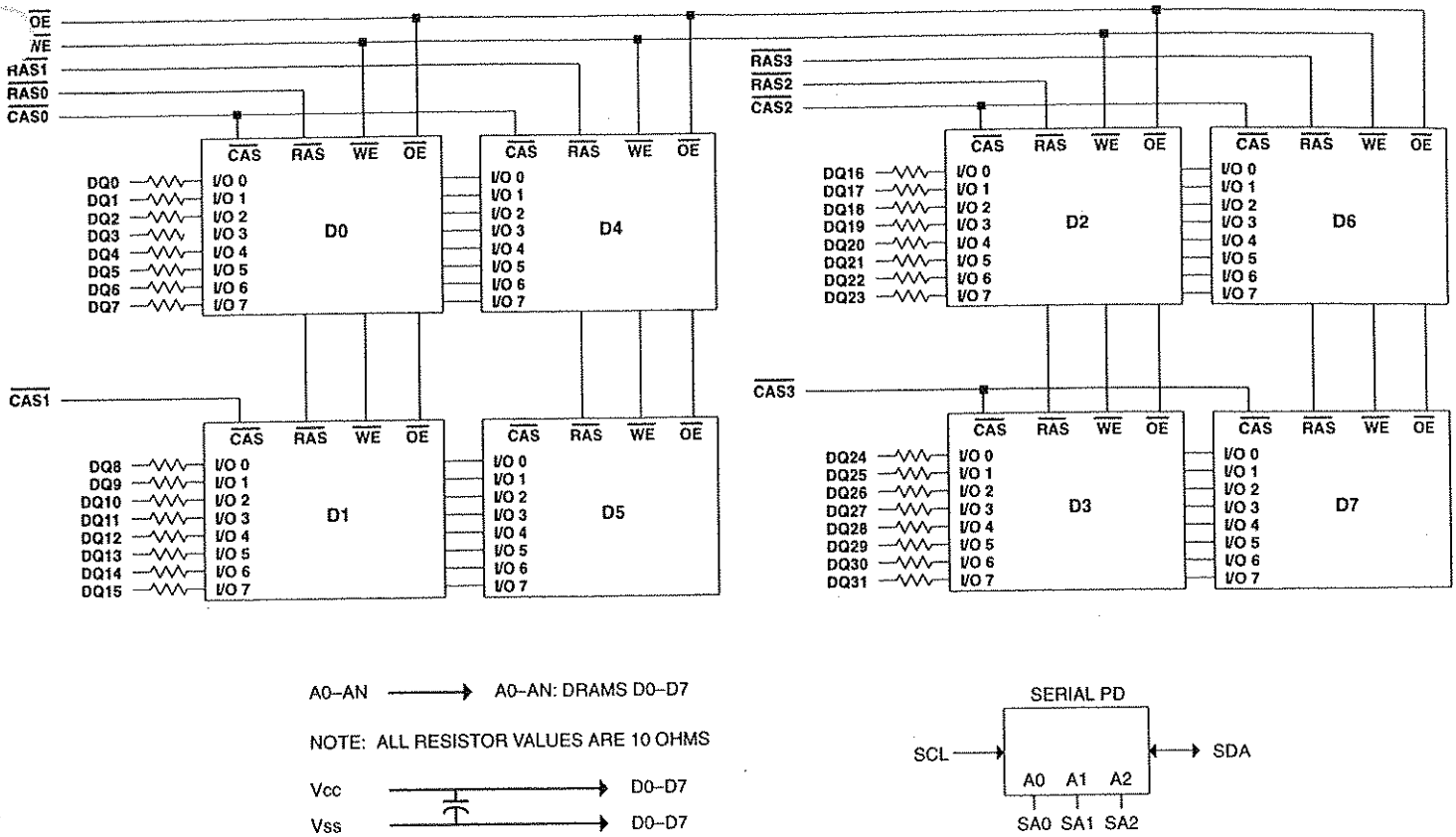



**Figure 4.4.8–AD**
**100 Pin X32 DRAM DIMM, 2 Bank with X8 DRAMs**



XILINX EXHIBIT 1012
Page 311

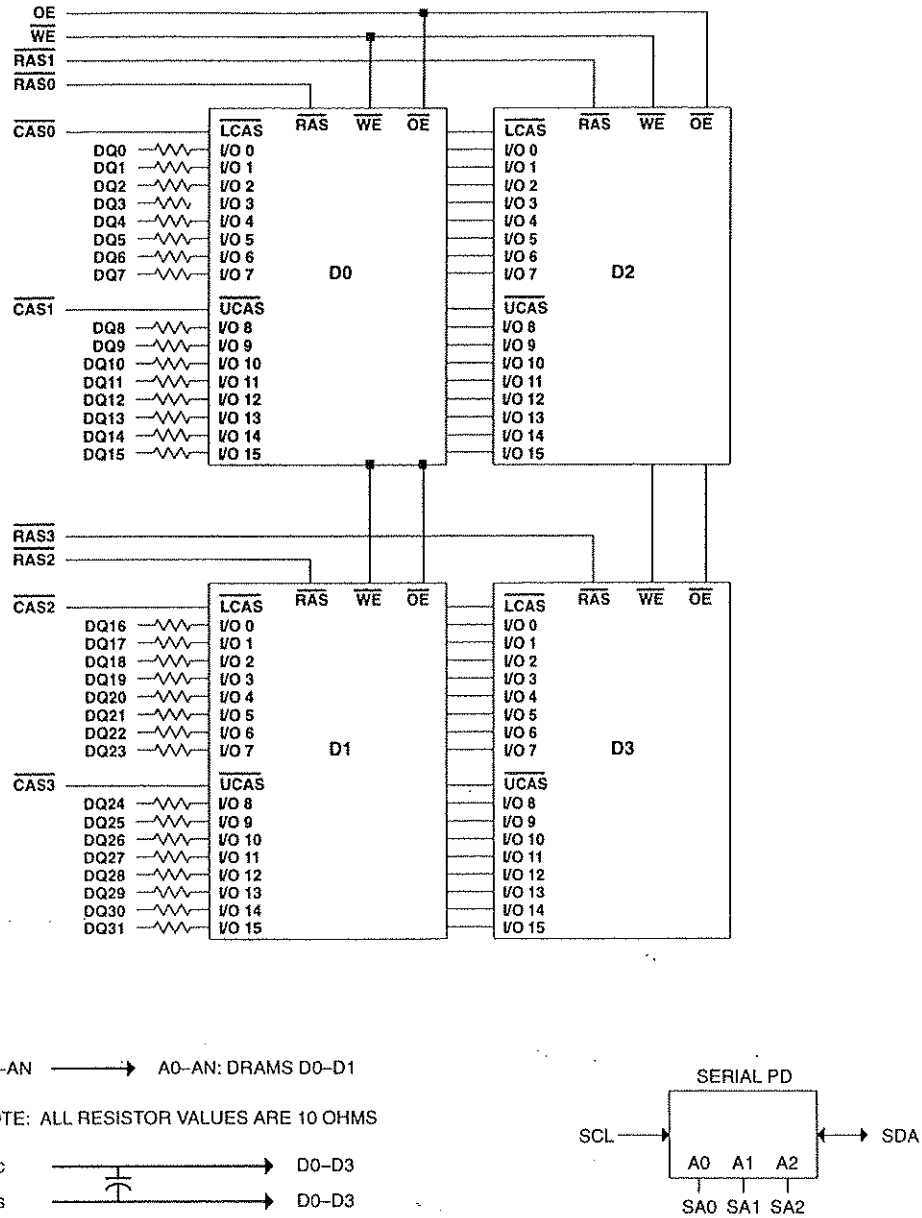



**Figure 4.4.8–AE**
**100 Pin X32 DRAM DIMM, 2 Bank with X16 DRAMs**

## 4.5 Eight Byte Memory Modules

### 4.5.1 – 168 PIN DRAM DIMM FAMILY

### 4.5.2 – 200 PIN DRAM DIMM FAMILY

### 4.5.3 – 168 PIN UNBUFFERED DRAM DIMM FAMILY

### 4.5.4 – 168 PIN UNBUFFERED SDRAM DIMM FAMILY

### 4.5.5 – 144 PIN DRAM SO–DIMM FAMILY

### 4.5.6 – 144 PIN SDRAM SO–DIMM FAMILY



XILINX EXHIBIT 1012
Page 313

## 4.5.1 – 168 PIN DRAM DIMM FAMILY

CAPACITY—256K, 512K, 1M, 2M, 4M, 8M, 16M, 32M, & 64M WORDS OF 64, 72, OR 80 BITS

DATA CONFIGURATIONS—Four DATA Word configurations are defined:
—64 BIT without PARITY
—72 BIT for PARITY CODES
—72 BIT & 80 BIT for ECC CODES

CONFIGURATION—21 Different Configurations are defined using various combinationa of X1, X4, X8, X9, X16 and X18 memories including 2 bank configurations using X4 devices.

LOGIC FEATURES—The modules contain "PRESENCE DETECT" and "IDENTITY" featurs that conist of output pins in the PDn and IDn fields which supply encoded values that define the storage capacity, configuration, data word configuration, refresh mode, and speed of the module.

PACKAGE—168 PIN JEDEC DIMM MEMORY MODULE

PIN ASSIGNMENTS AND PD TABLES—Figs. 4.5.1–A, 4.5.1–B, & 4.5.1–C

CAPACITY / DEVICE CONFIGURATION TABLE—Fig. 4.5.1–D

CONFIGURATION BLOCK DIAGRAM—Figs. 4.5.1–E through 4.5.1–AB

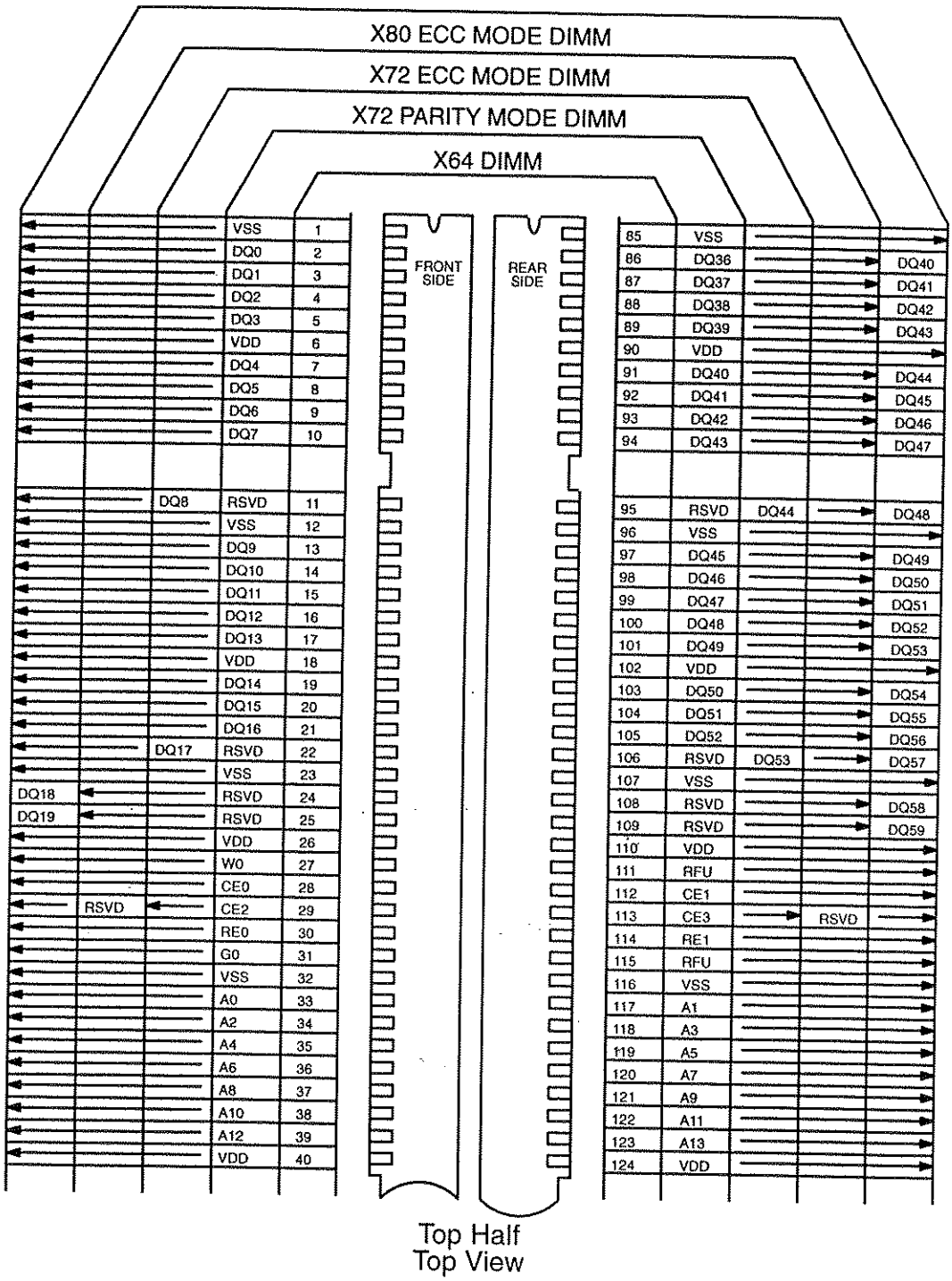



**Figure 4.5.1–A**
**168 PIN, 64, 72, or 80 BIT DIMM PINOUT, TOP HALF**

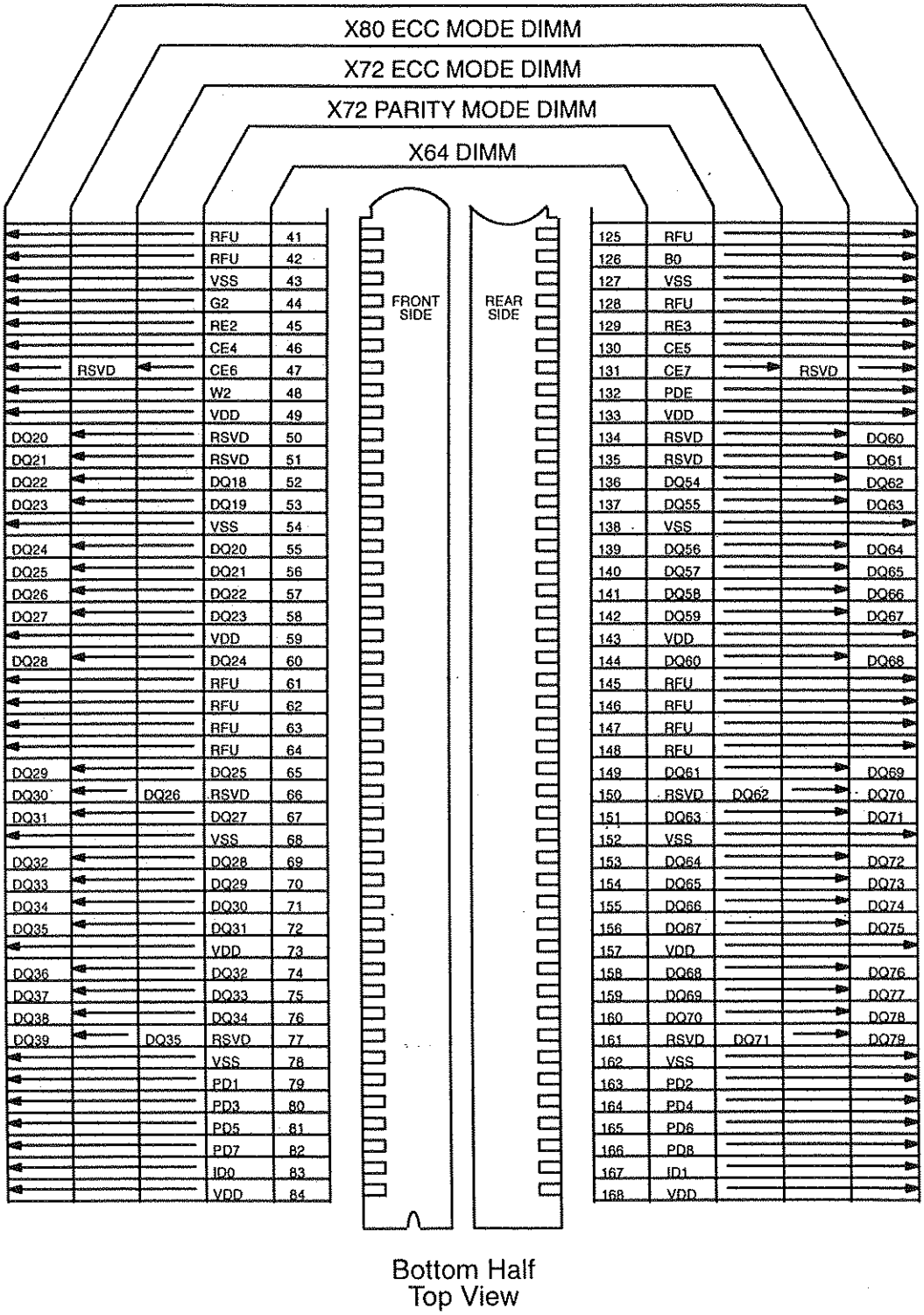



**Figure 4.5.1–B**
**168 PIN, 64, 72, or 80 BIT DIMM PINOUT, BOTTOM HALF**

| PD 4 | PD 3 | PD 2 | PD 1 | DIMM CONFIGURATION (Parity, ECC) | # BANKS | DRAM CONFIGURATION | DRAM ROW ADDR. | DRAM COL. ADDR. | Av. REFRESH INTERVAL NORMAL (µS) | SLOW |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 256K X 64/72, 72 | 1 | 256K X 16/18 | 9 | 9 | 15.6 | 125 |
| 0 | 0 | 0 | 1 | 512K X 64/72, 72 | 2 | 256K X 16/18 | 9 | 9 | 15.6 | 125 |
| 0 | 0 | 1 | 0 | 512K X 64/72, 72/80 | 1 | 512K X 8/9 | 10 | 9 | 15.6 | 125 |
| 0 | 0 | 1 | 1 | 1M X 64/72, 72/80 | 2 | 512K X 8/9 | 10 | 9 | 15.6 | 125 |
| 0 | 1 | 0 | 0 | 1M X 64/72, 72/80 | 1 | 1M X 4/16/18 | 10 | 10# | 15.6 | 125 |
| 0 | 1 | 0 | 1 | 2M X 64/72, 72/80 | 2 | 1M X 4/16/18 | 10 | 10# | 15.6 | 125 |
| 0 | 1 | 1 | 0 | 1M X 64/72, 72 | 1 | 1M X 16/18 | 12 | 8 | 15.6 | 31.2 |
| 1 | 0 | 0 | 0 | 2M X 64/72, 72 | 2 | 1M X 16/18 | 12 | 8 | 15.6 | 31.2 |
| 1 | 0 | 0 | 1 | 2M X 64/72, 72/80 | 1 | 2M X 8 | 11 | 10 | 15.6 | 62.5 |
| 1 | 0 | 1 | 0 | 4M X 64/72, 72/80 | 2 | 2M X 8 | 11 | 10 | 15.6 | 62.5 |
| 1 | 0 | 1 | 1 | 4M X 72 | 1 | 4M X 1/4 | 12** | 11** | 15.6 | 31.2 |
| 1 | 0 | 1 | 1 | 4M X 64, 72/80 | 1 | 4M X 4/16 | 12/11 | 10/11 | 15.6 | 31.2/62.5 |
| 1 | 1 | 0 | 0 | 8M X 64/72, 72/80 | 2 | 4M X 4/16 | 12/11 | 10/11 | 15.6 | 31.2/62.5 |
| 1 | 1 | 0 | 1 | 8M X 64/72, 72/80 | 1 | 8M X 8 | 12 | 11 | 15.6 | 31.2 |
| 1 | 1 | 1 | 0 | 16M X 64/72, 72/80 | 2 | 8M X 8 | 12 | 11 | 15.6 | 31.2 |
| 1 | 1 | 1 | 1 | 16M X 64/72, 72/80 | 1 | 16M X 4 | 13/12 | 11/12 | 15.6 | TBD/31.2 |
| 0 | 0 | 0 | 0 | 16M X 64/72, 72 | 1 | 16M X 16 | 13/12 | 11/12 | 15.6 | TBD/31.2 |
| 0 | 0 | 0 | 1 | 32M X 64/72, 72/80 | 2 | 16M X 4/16 | 13/12 | 11/12 | 15.6 | TBD/31.2 |
| 0 | 0 | 1 | 0 | 32M X 64/72, 72/80 | 1 | 32M X 8 | 14/13 | 11/12 | 7.8/15.6 | TBD* |
| 0 | 0 | 1 | 1 | 64M X 64/72, 72/80 | 2 | 32M X 8 | 14/13 | 11/12 | 7.8/15.6 | TBD* |
| 0 | 1 | 0 | 0 | 64M X 64/72, 72/80 | 1 | 64M X 4 | 14/13 | 12/13 | 7.8/15.6 | TBD* |
| 0 | 1 | 1 | 1 | Expansion | | | | | | |

Note 1) * These modules using 256M devices are for reference only and will be further defined in the future.
Note 2) 1 = Logic high ; 0 = Logic low; In Table Information.
Note 3) ** This addressing includes a redundant address to allow mixing of 12/10(X4) and 11/11(X1) DRAMs
Note 4) # 1M X 16/18 DRAMS with 10/10 addressing may dissipate excessive power in many applications. Care must be taken to ensure device thermal limits are not exceeded. 12/8 addressing is provided as a lower power option.
PD Note: PD & ID terminals must each be pulled up through a resistor to VDD at the next higher level assembly. PDs will either be open or driven to VOH or driven to VOL via on–board buffer circuits.
ID Note: IDs will either be open (NC) or connected directly to VSS without a buffer.

| | PD7 | PD6 |
|---|---|---|
| SPEED (tRAC) | 82 | 165 |
| 80 ns | 0 | 1 |
| 70 ns | 1 | 0 |
| 60 ns | 1 | 1 |
| 50 ns | 0 | 0 |
| 40 ns | 0 | 1 |
| **PD SPEED TABLE** | | |

| | PD8 | ID0 |
|---|---|---|
| CONFIGURATION | 166 | 83 |
| X64 | 1 | 0 |
| X72 PARITY | 1 | 1 |
| X72 ECC | 0 | 0 |
| X80 ECC | 0 | 1 |
| **DATA CONFIGURATION** | | |

| | ID1 |
|---|---|
| REFRESH MODE | 167 |
| NORMAL | 0 |
| SELF–REFRESH | 1 |
| **REFRESH MODE** | |

| DATA ACCESS MODE | PD5 |
|---|---|
| | 81 |
| FAST PAGE | 0 |
| FP W/EDO | 1 |
| **EDO DETECTION** | |

**Figure 4.5.1–C**
**168 PIN, 64, 72, or 80 BIT DIMM PRESENCE DETECT & CONFIGURATION TABLES**

| 64, 72, & 80 BIT DRAM DIMM CAPACITY IN M BYTE | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Memory Device / DIMM Configuration | 4M DRAM | | | | | 16M DRAM | | | | | 64M DRAM | | | | | 256M DRAM | | | | |
| | 256K | | 512K | | 1M | 1M | | 2M | | 4M | 4M | | 8M | | 16M | 16M | | 32M | | 64M |
| | X18 | X16 | X9 | X8 | X4 | X18 | X16 | X9 | X8 | X4 | X18 | X16 | X9 | X8 | X4 | X18 | X16 | X9 | X8 | X4 |
| 256K X 64 | | 4 | | | | | | | | | | | | | | | | | | |
| 256K X 72 | 4 | | | | | | | | | | | | | | | | | | | |
| 256K X 72 (ECC) | 4 | | | | | | | | | | | | | | | | | | | |
| 256K X 80 (ECC) | | | | | | | | | | | | | | | | | | | | |
| 512 X 64 | | 8 | | 8 | | | | | | | | | | | | | | | | |
| 512K X 72 | 8 | | 8 | | | | | | | | | | | | | | | | | |
| 512K X 72 (ECC) | 8 | | 8 | 9 | | | | | | | | | | | | | | | | |
| 512K X 80 (ECC) | | | | 10 | | | | | | | | | | | | | | | | |
| 1M X 64 | | | | 16 | 16 | | 4 | | | | | | | | | | | | | |
| 1M X 72 | | | 16 | | 18 | 4 | | | | | | | | | | | | | | |
| 1M X 72 (ECC) | | | 16 | 18 | 18 | 4 | | | | | | | | | | | | | | |
| 1M X 80 (ECC) | | | | 20 | 20 | | | | | | | | | | | | | | | |
| 2M X 64 | | | | | | | 8 | | 8 | | | | | | | | | | | |
| 2M X 72 | | | | | | 8 | | 8 | | | | | | | | | | | | |
| 2M X 72 (ECC) | | | | | | 8 | | 8 | 9 | | | | | | | | | | | |
| 2M X 80 (ECC) | | | | | | | | | 10 | | | | | | | | | | | |
| 4M X 64 | | | | | | | | | 16 | 16 | | 4 | | | | | | | | |
| 4M X 72 | | | | | | | | 16 | | 18 | 4 | | | | | | | | | |
| 4M X 72 (ECC) | | | | | | | | 16 | 18 | 18 | 4 | | | | | | | | | |
| 4M X 80 (ECC) | | | | | | | | | 20 | 20 | | | | | | | | | | |
| 8M X 64 | | | | | | | | | | | | 8 | | 8 | | | | | | |
| 8M X 72 | | | | | | | | | | | 8 | | 8 | | | | | | | |
| 8M X 72 (ECC) | | | | | | | | | | | 8 | | 8 | 9 | | | | | | |
| 8M X 80 (ECC) | | | | | | | | | | | | | | 10 | | | | | | |
| 16M X 64 | | | | | | | | | | | | | | 16 | 16 | | 4 | | | |
| 16M X 72 | | | | | | | | | | | | | 16 | | 18 | 4 | | | | |
| 16M X 72 (ECC) | | | | | | | | | | | | | 16 | 18 | 18 | 4 | | | | |
| 16M X 80 (ECC) | | | | | | | | | | | | | | 20 | 20 | | | | | |
| 32M X 64 | | | | | | | | | | | | | | | | | 8 | | 8 | |
| 32M X 72 | | | | | | | | | | | | | | | | 8 | | 8 | | |
| 32M X 72 (ECC) | | | | | | | | | | | | | | | | 8 | | 8 | 9 | |
| 32M X 80 (ECC) | | | | | | | | | | | | | | | | | | | 10 | |
| 64M X 64 | | | | | | | | | | | | | | | | | | | 16 | 16 |
| 64M X 72 | | | | | | | | | | | | | | | | | | 16 | | 18 |
| 64M X 72 (ECC) | | | | | | | | | | | | | | | | | | 16 | 18 | 18 |
| 64M X 80 (ECC) | | | | | | | | | | | | | | | | | | | 20 | 20 |

**Figure 4.5.1–D**
**168 PIN, 64, 72, & 80 BIT DRAM DIMM Capacity Table**

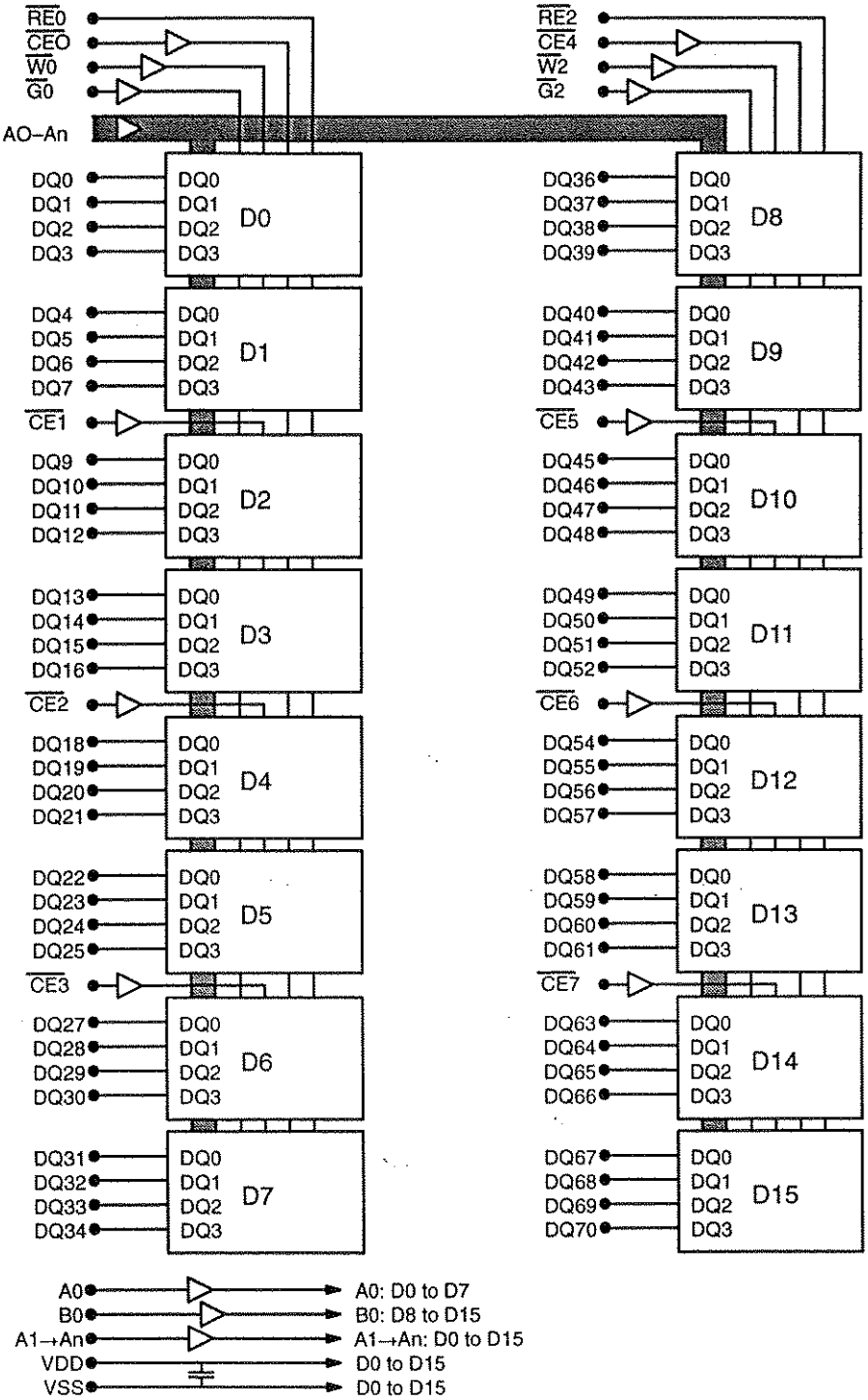



**Figure 4.5.1–E**
**168 PIN, X64 DRAM DIMM, 1 bank with X4 DRAMs**

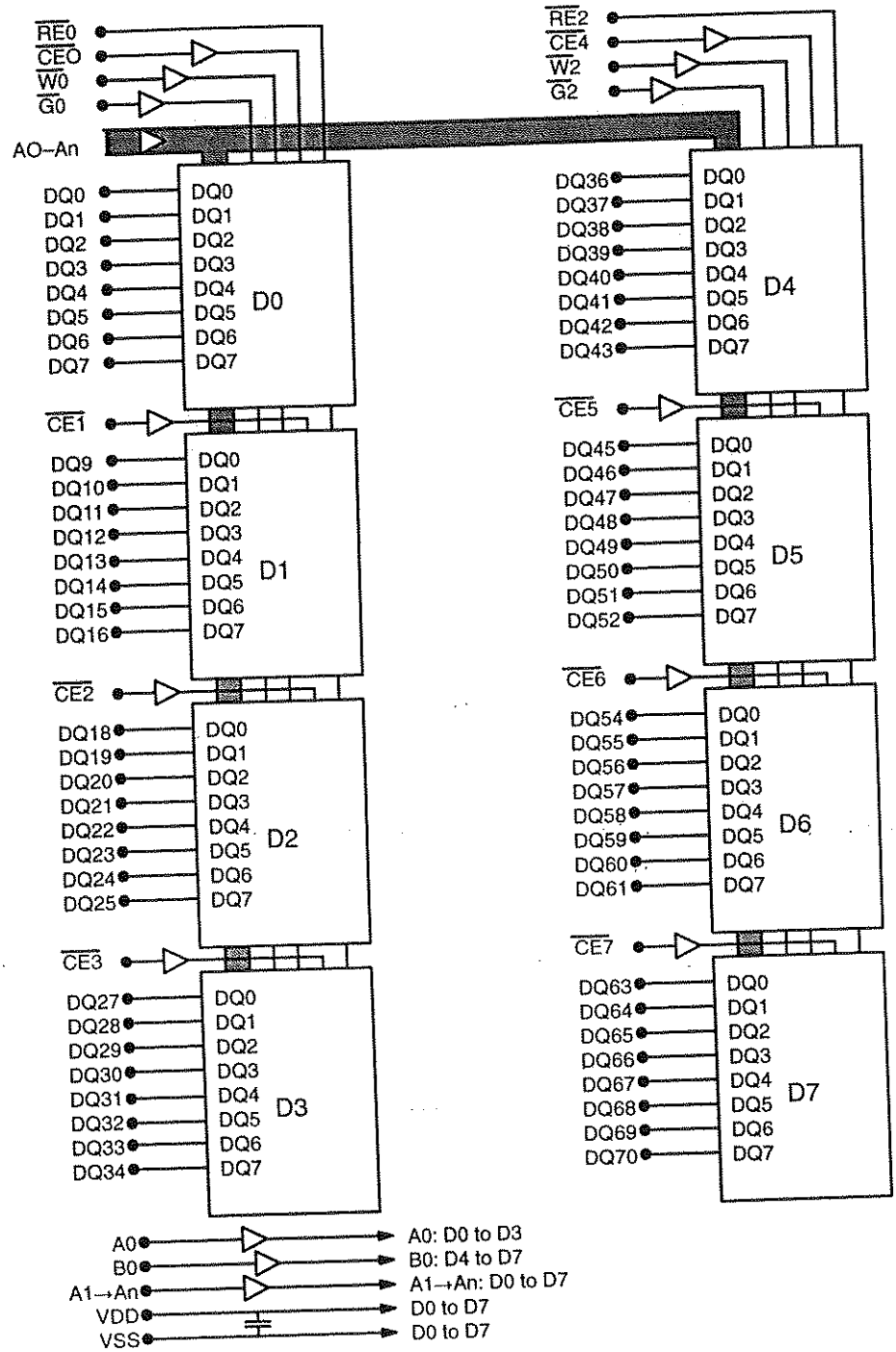



**Figure 4.5.1–F**
**168 PIN, X64 DRAM DIMM, 1 bank with X8 DRAMs**

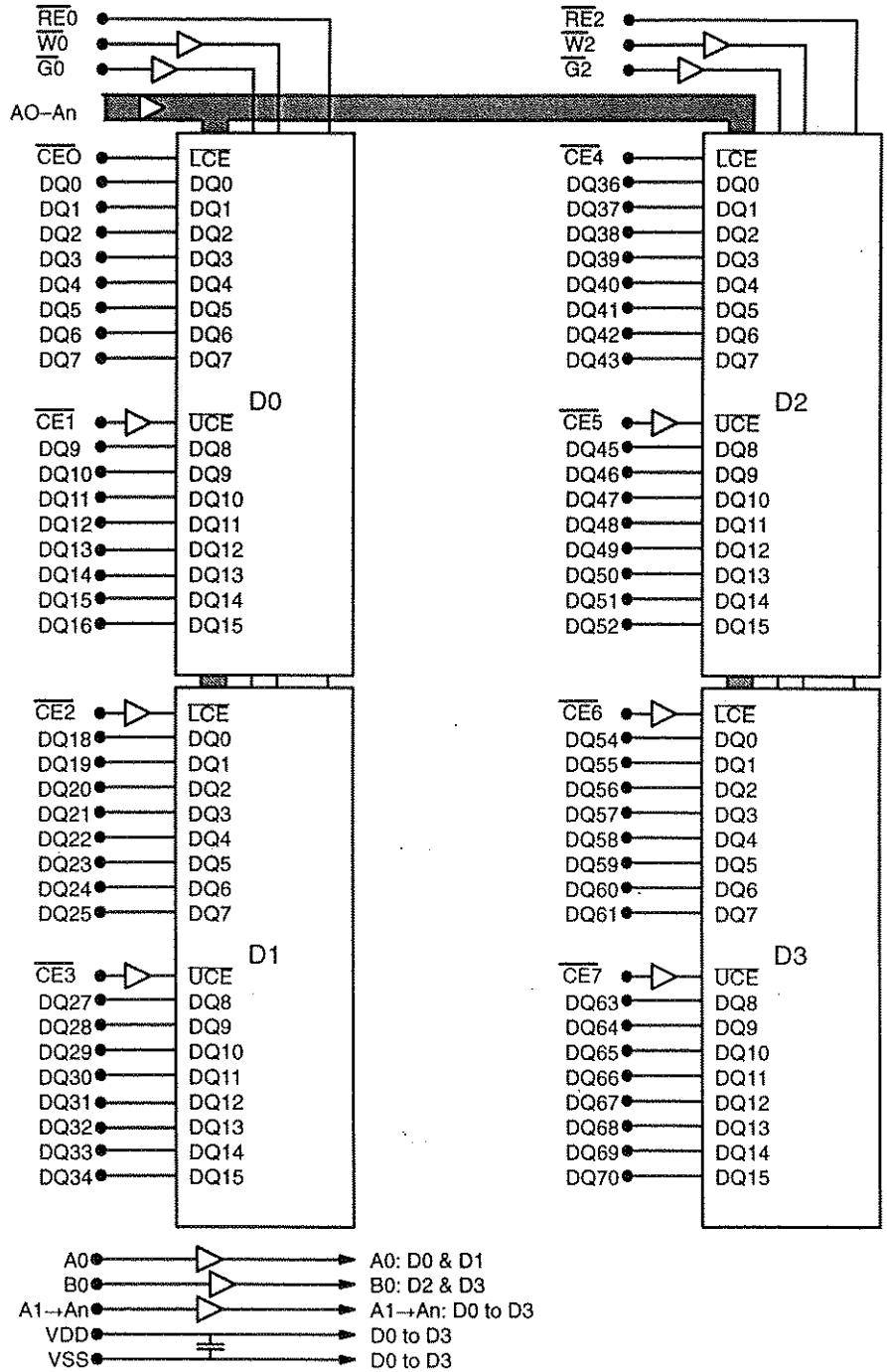



**Figure 4.5.1–G**
**168 PIN, X64 DRAM DIMM, 1 bank with X16 DRAMs**

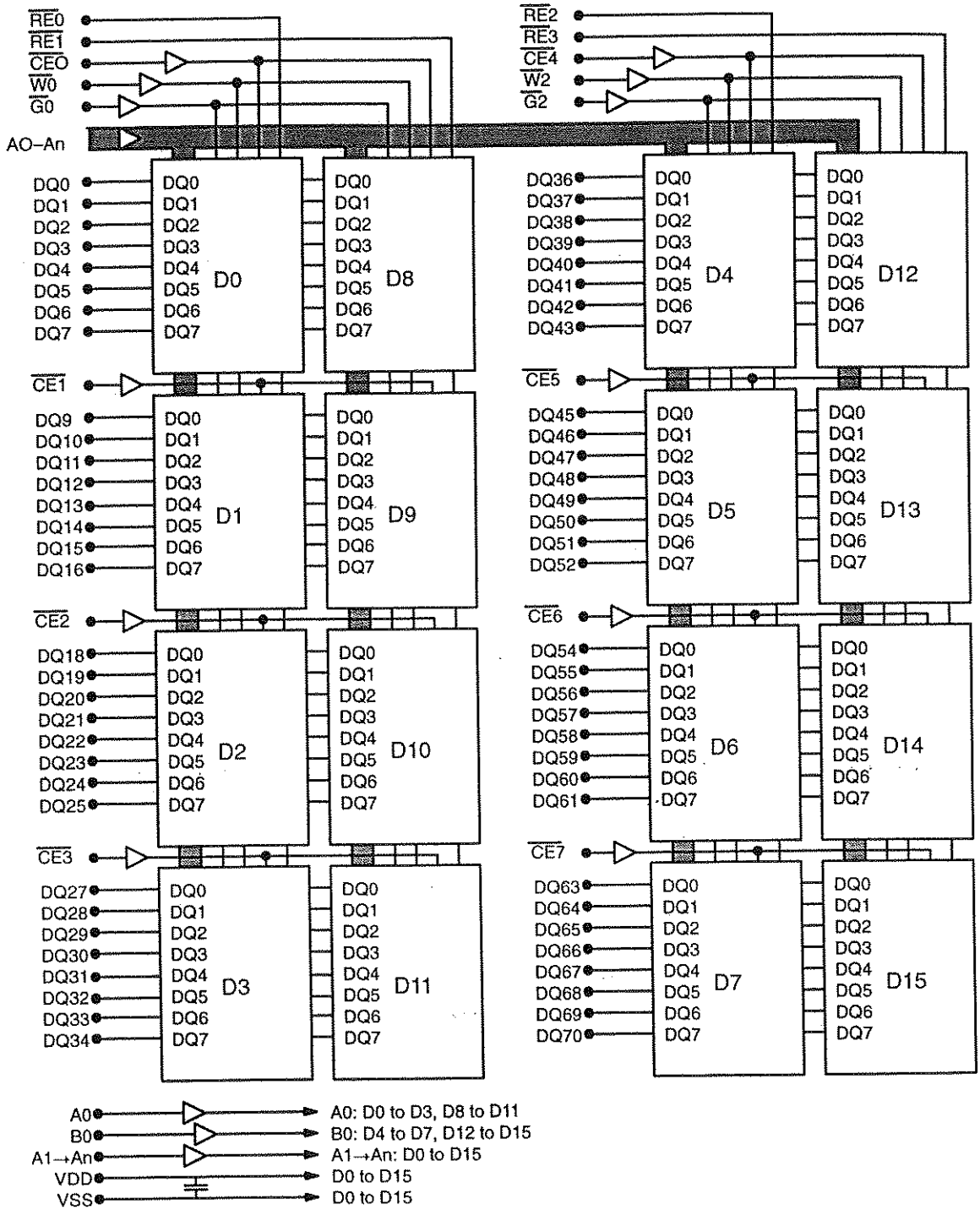



**Figure 4.5.1–H**
**168 PIN, X64 DRAM DIMM, 2 banks with X8 DRAMs**

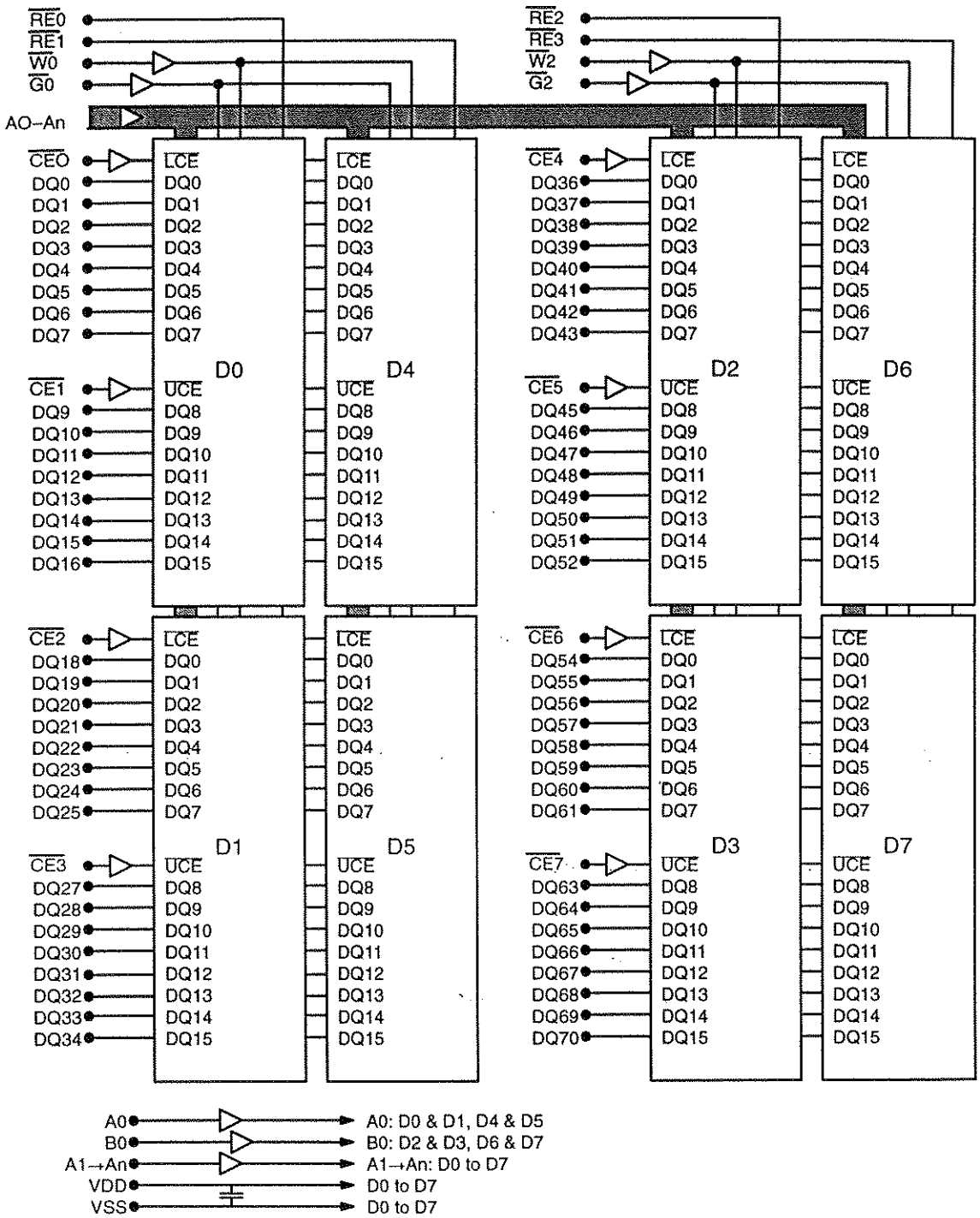



**Figure 4.5.1–I**
**168 PIN, X64 DRAM DIMM, 2 banks with X16 DRAMs**

Release 4c7

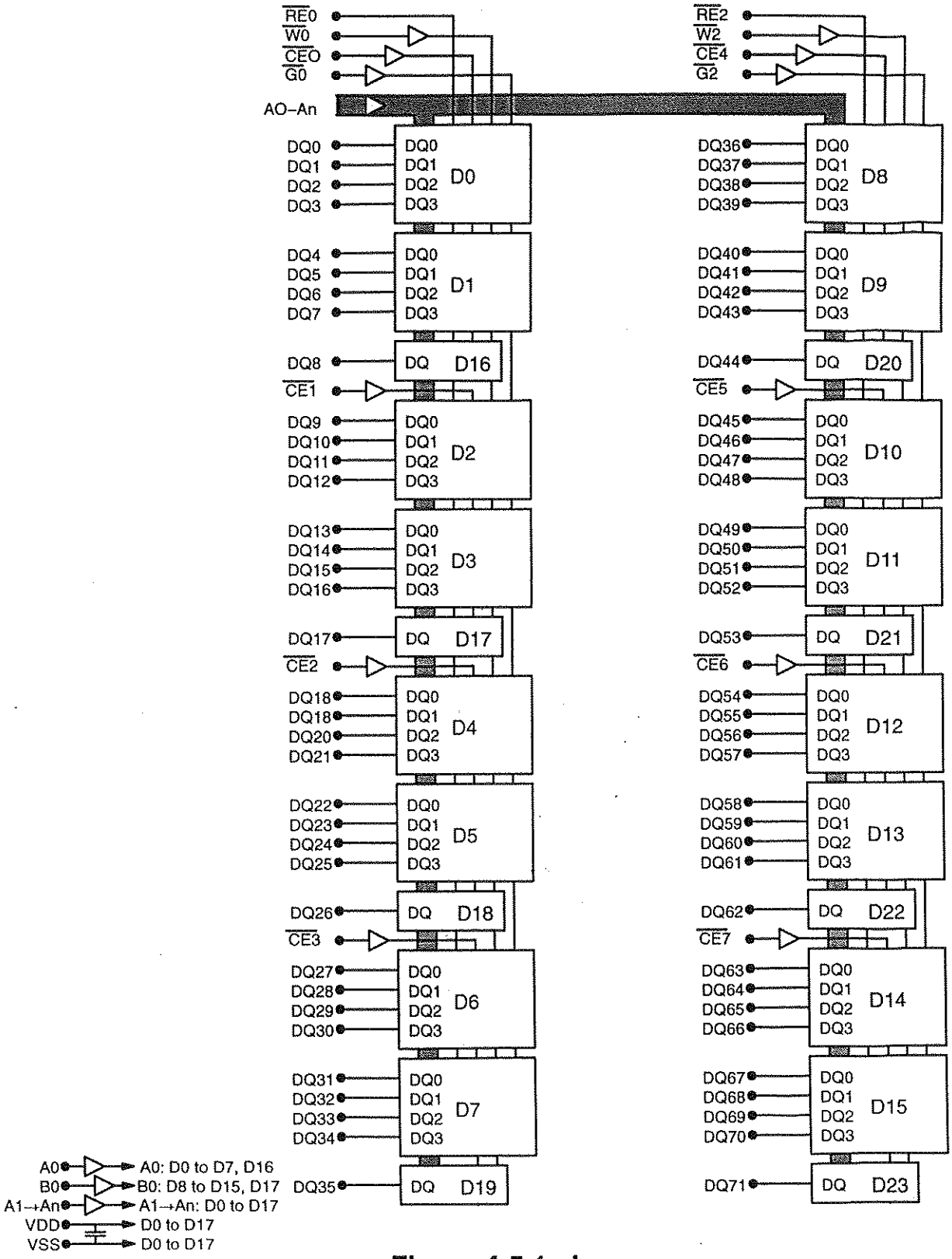



**Figure 4.5.1–J**

**168 PIN, X72 (Parity mode) DRAM DIMM, 1 bank with X4 & X1 DRAMs**

**Release 4c7**

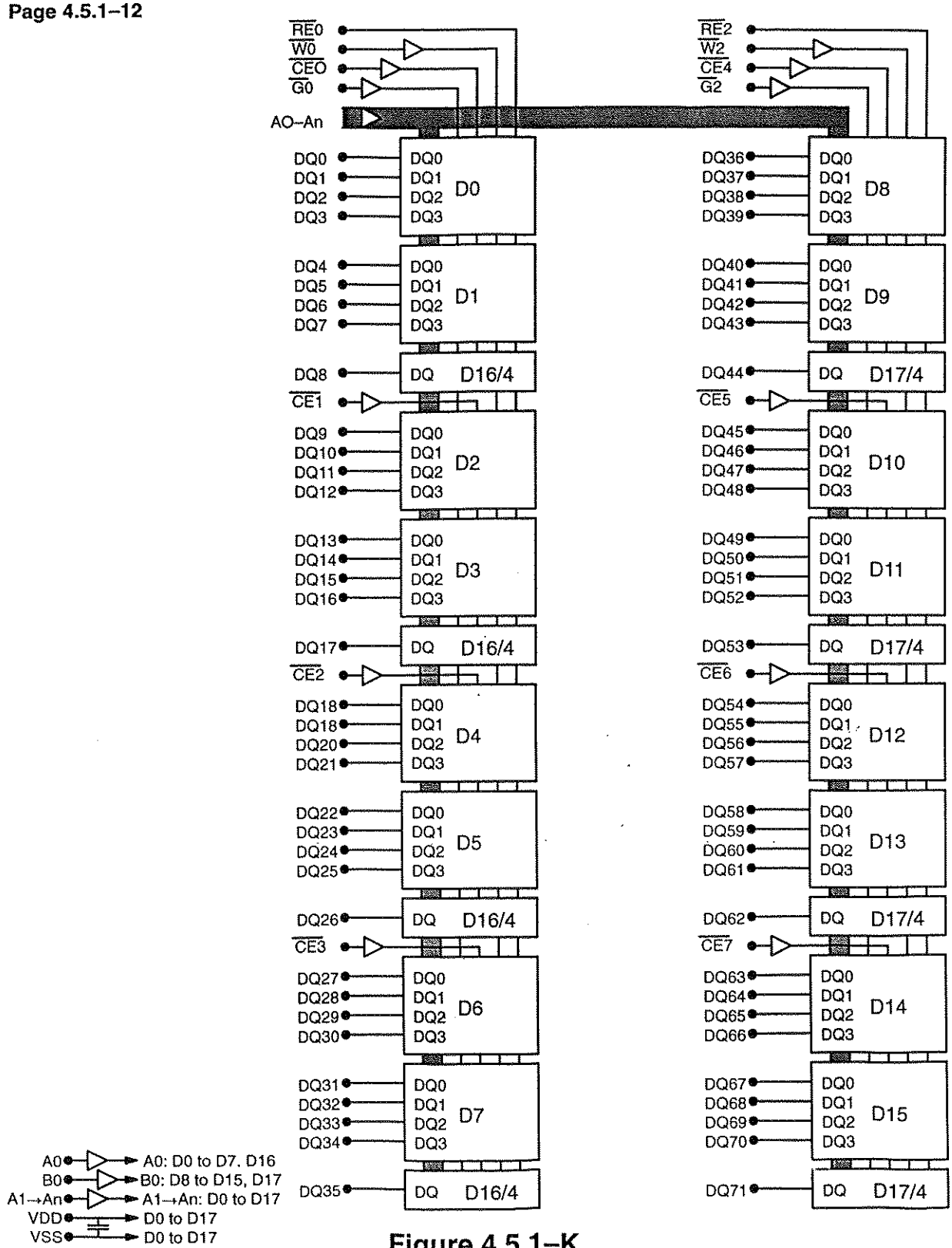



**Figure 4.5.1–K**
**168 PIN, X72 (Parity mode) DRAM DIMM, 1 bank with X4 & X4 W/4 $\overline{CE}$ DRAMs**

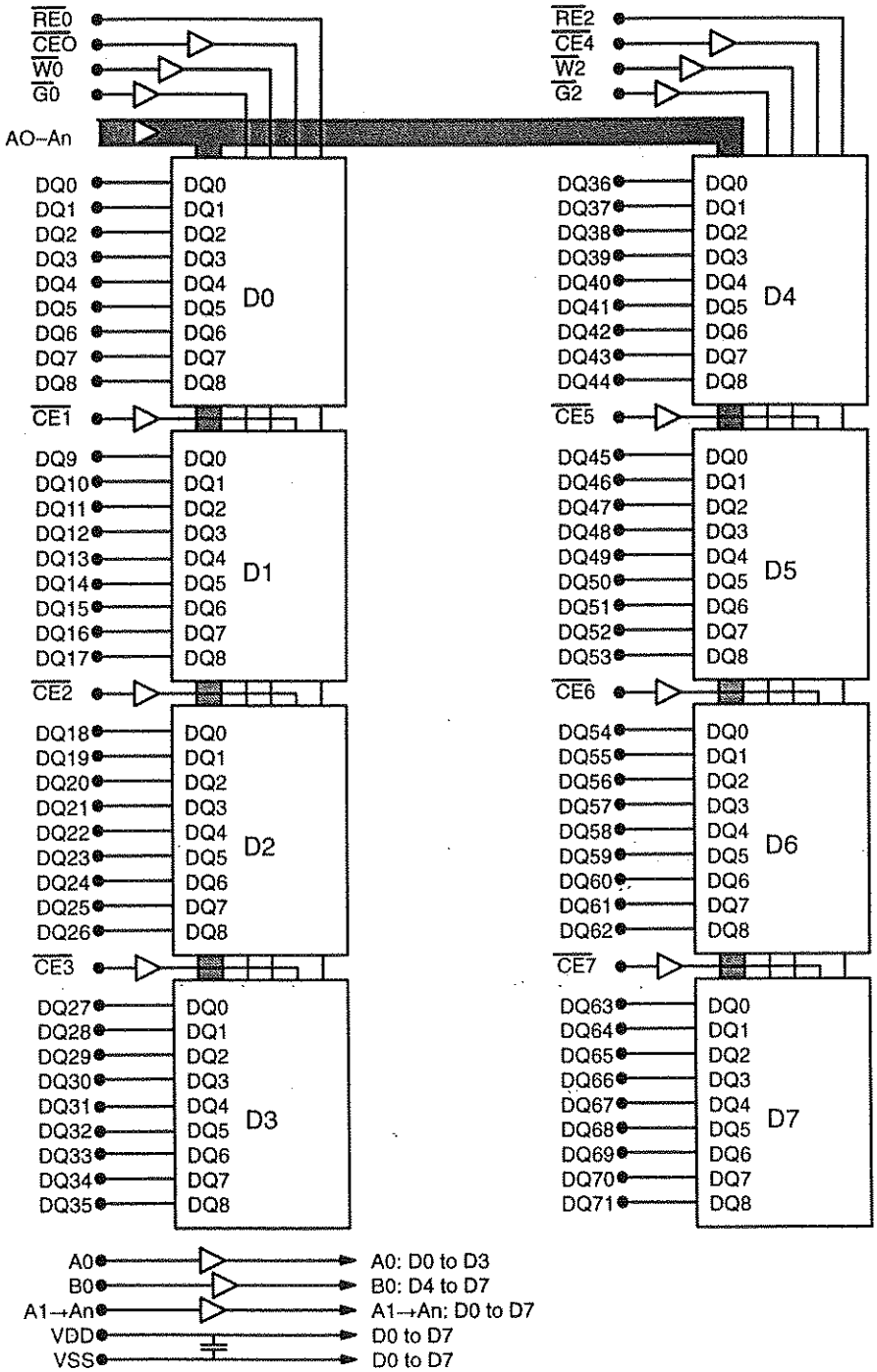



**Figure 4.5.1–L**
**168 PIN, X72 (Parity mode) DRAM DIMM, 1 bank with X9 DRAMs**

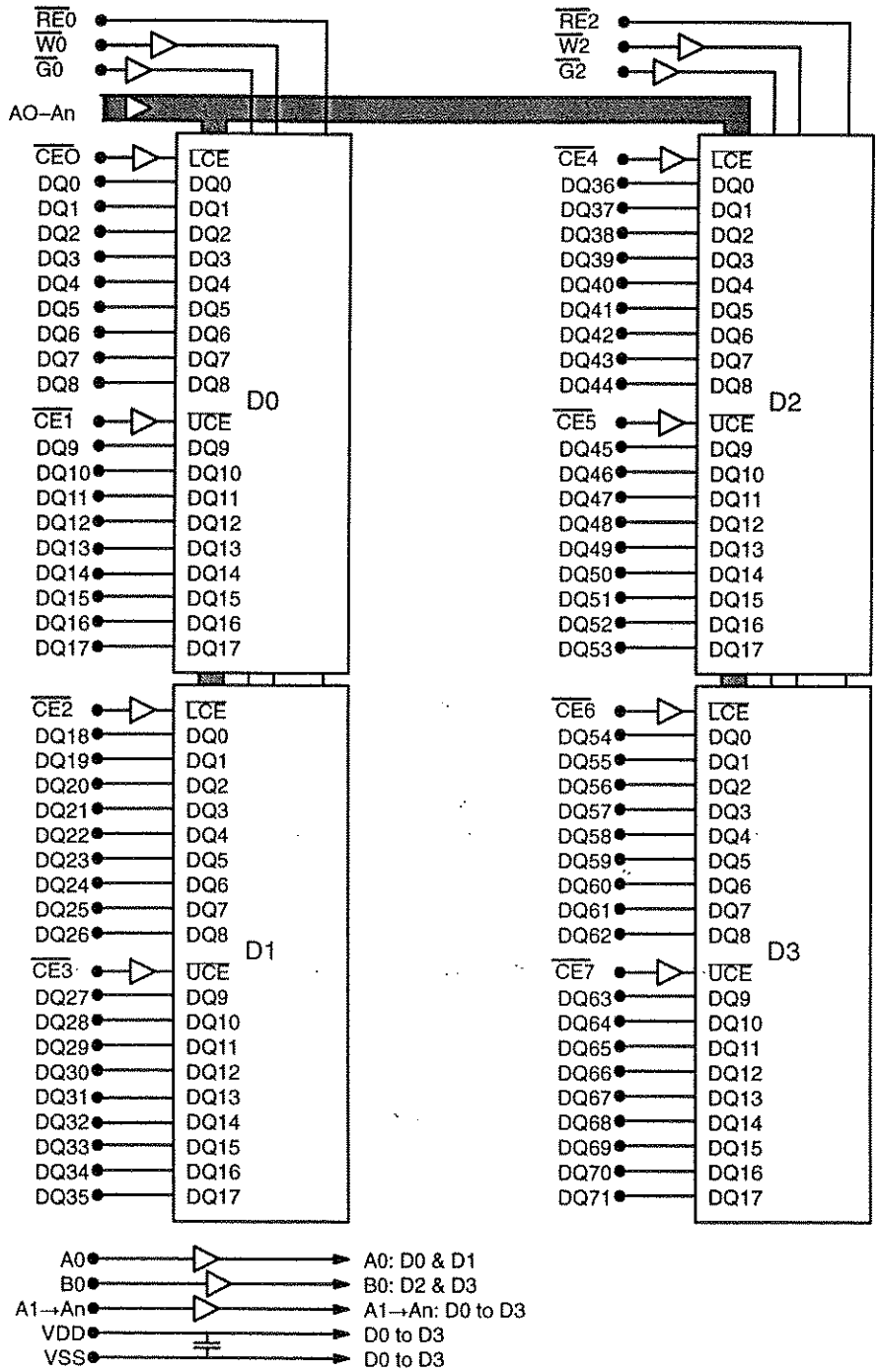



**Figure 4.5.1–M**
**168 PIN, X72 (Parity mode) DRAM DIMM, 1 bank with X18 DRAMs**
**Release 4c7**

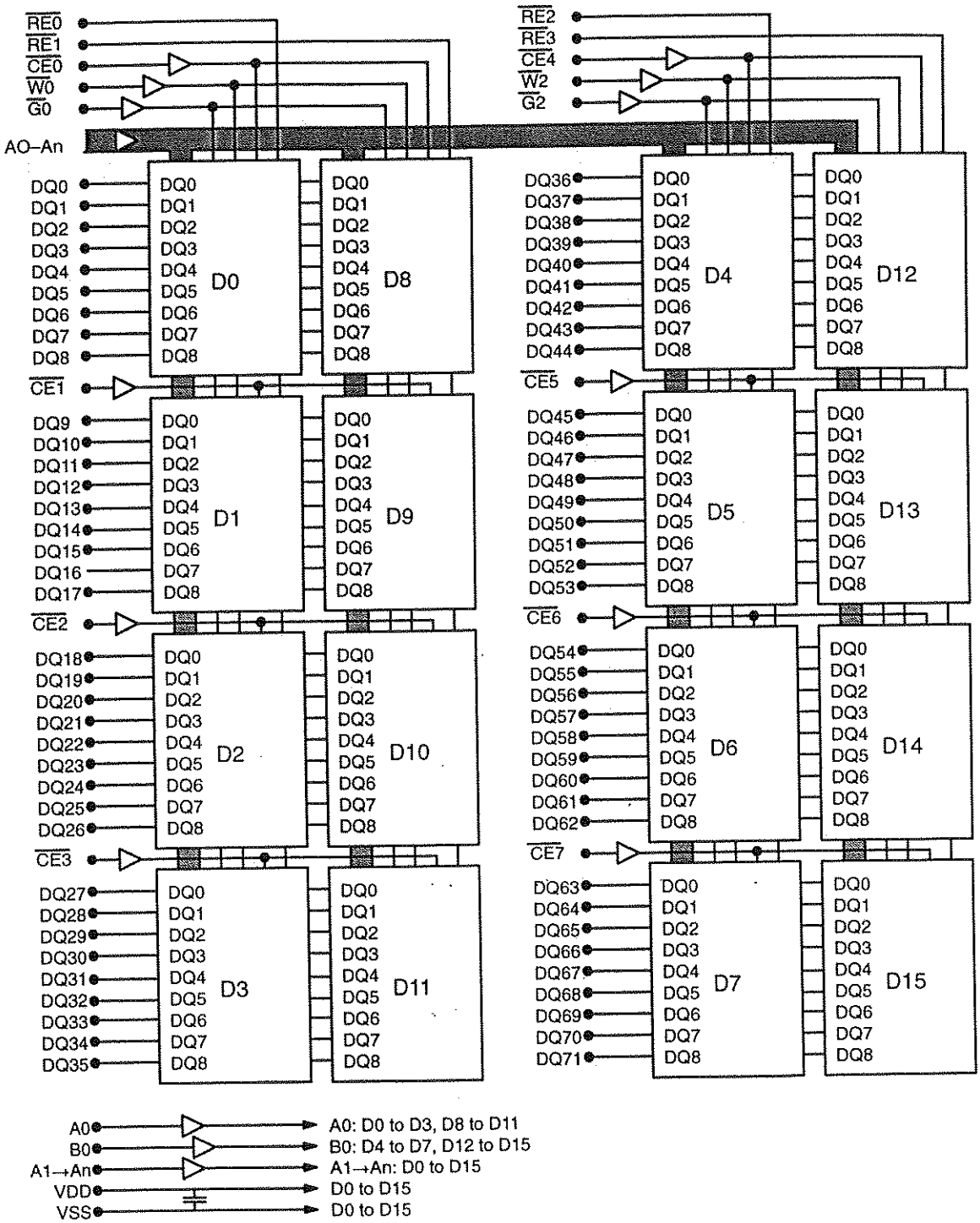



**Figure 4.5.1–N**
**168 PIN, X72 (Parity mode) DRAM DIMM, 2 banks with X9 DRAMs**

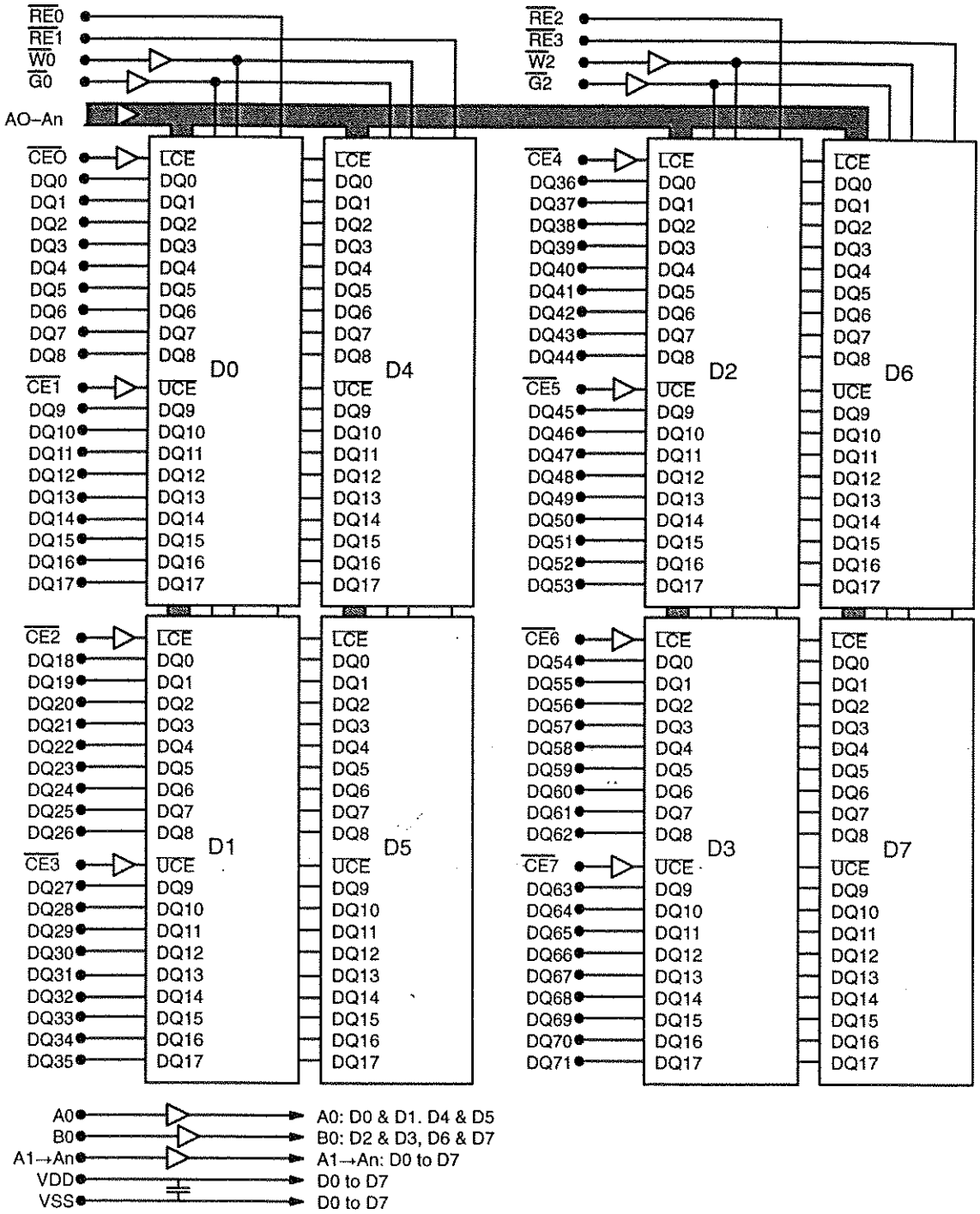



**Figure 4.5.1–O**
**168 PIN, X72 (Parity mode) DRAM DIMM, 2 bank with X18 DRAMs**
**Release 4–7**

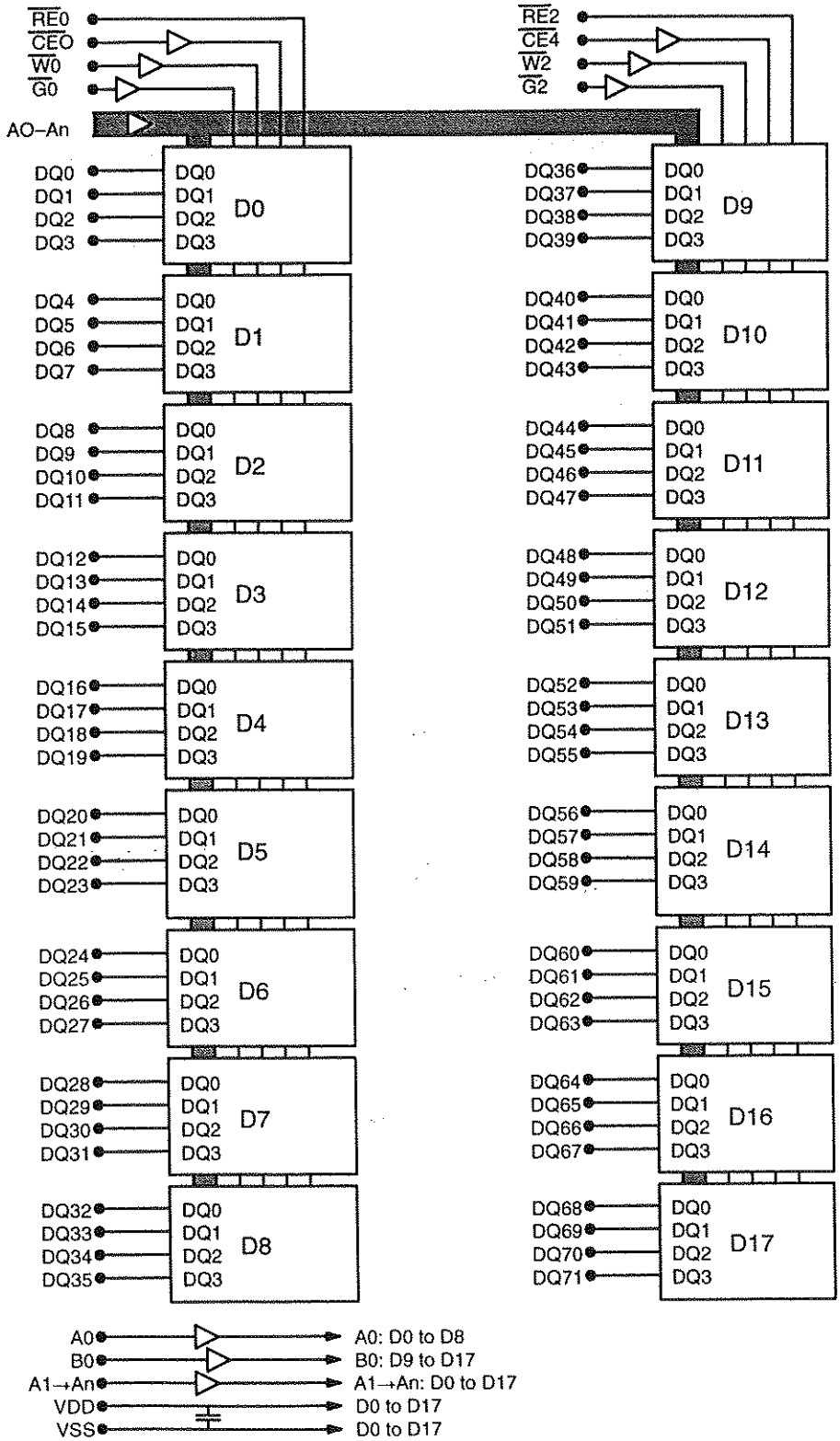
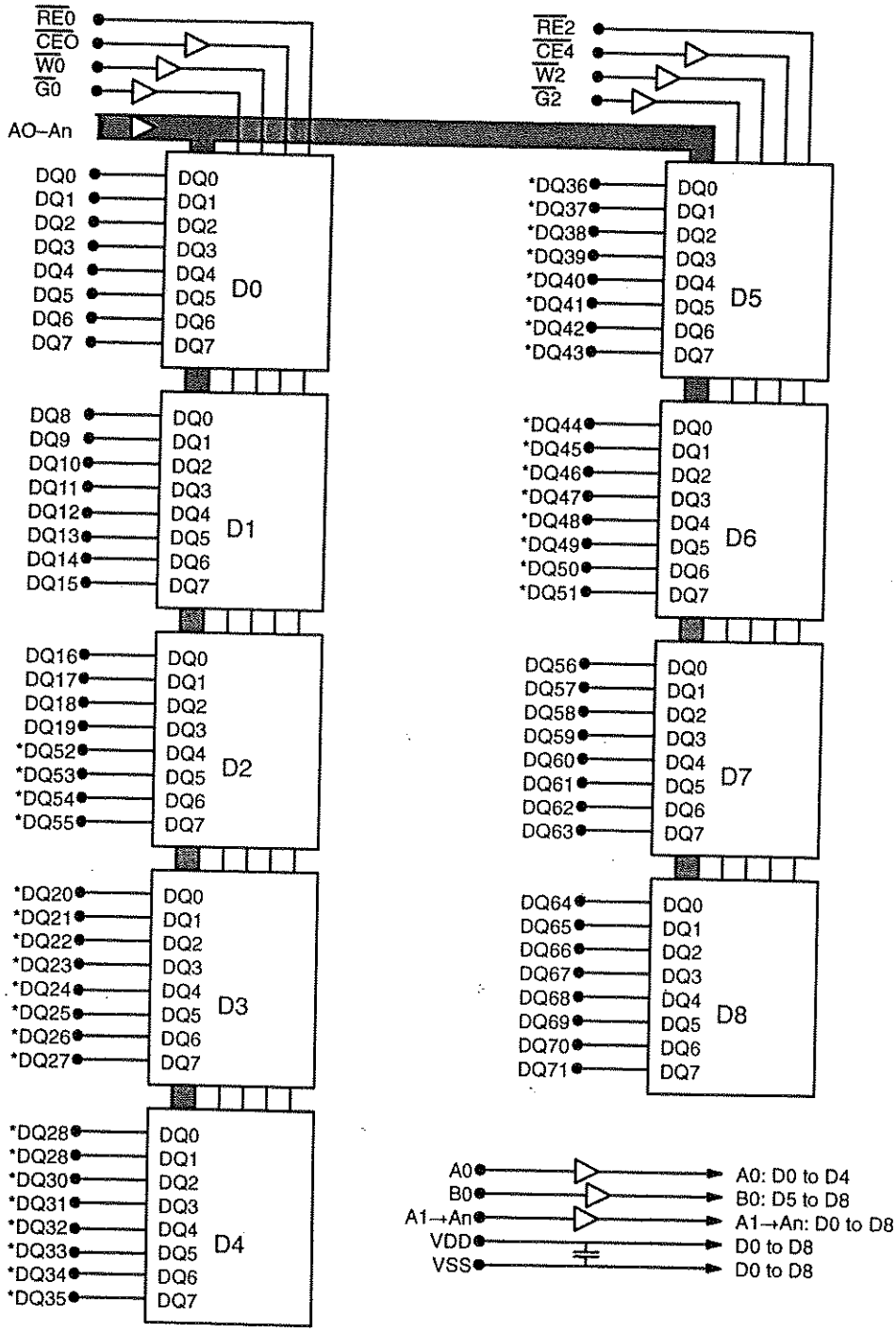


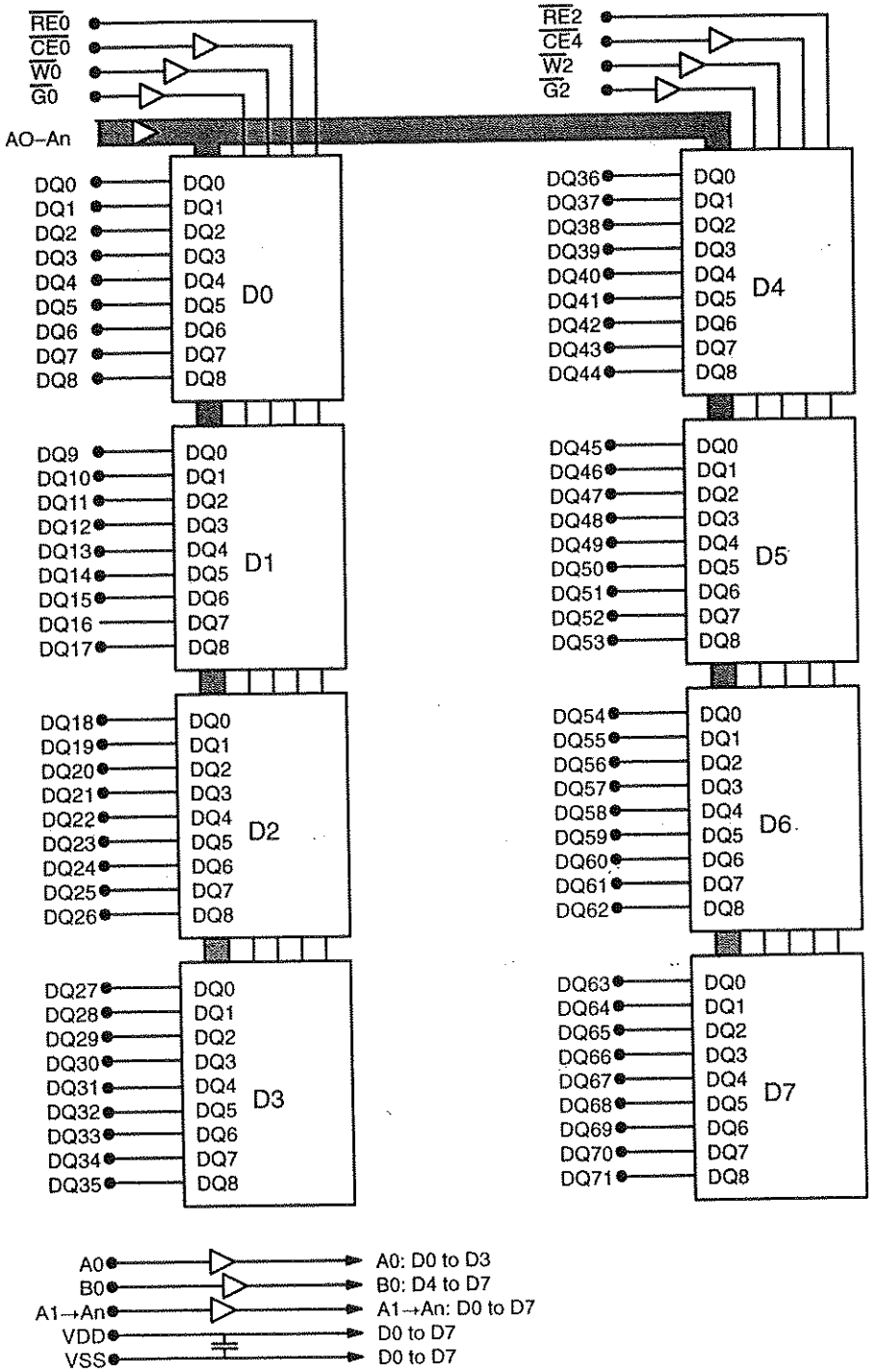

**Figure 4.5.1–P**
**168 PIN, X 72 (ECC mode) DRAM DIMM, 1 bank with X4 DRAMs**
**Release 4c7**




* Note: The location of data pins DQ–20 through DQ–55 have been changed in Release 7

## Figure 4.5.1–Q
## 168 PIN, X72 (ECC mode) DRAM DIMM, 1 bank with X8 DRAMs

**Release 4–r7**




## Figure 4.5.1–R
## 168 PIN, X72 (ECC mode) DRAM DIMM, 1 bank with X9 DRAMs

**Release 4c7**

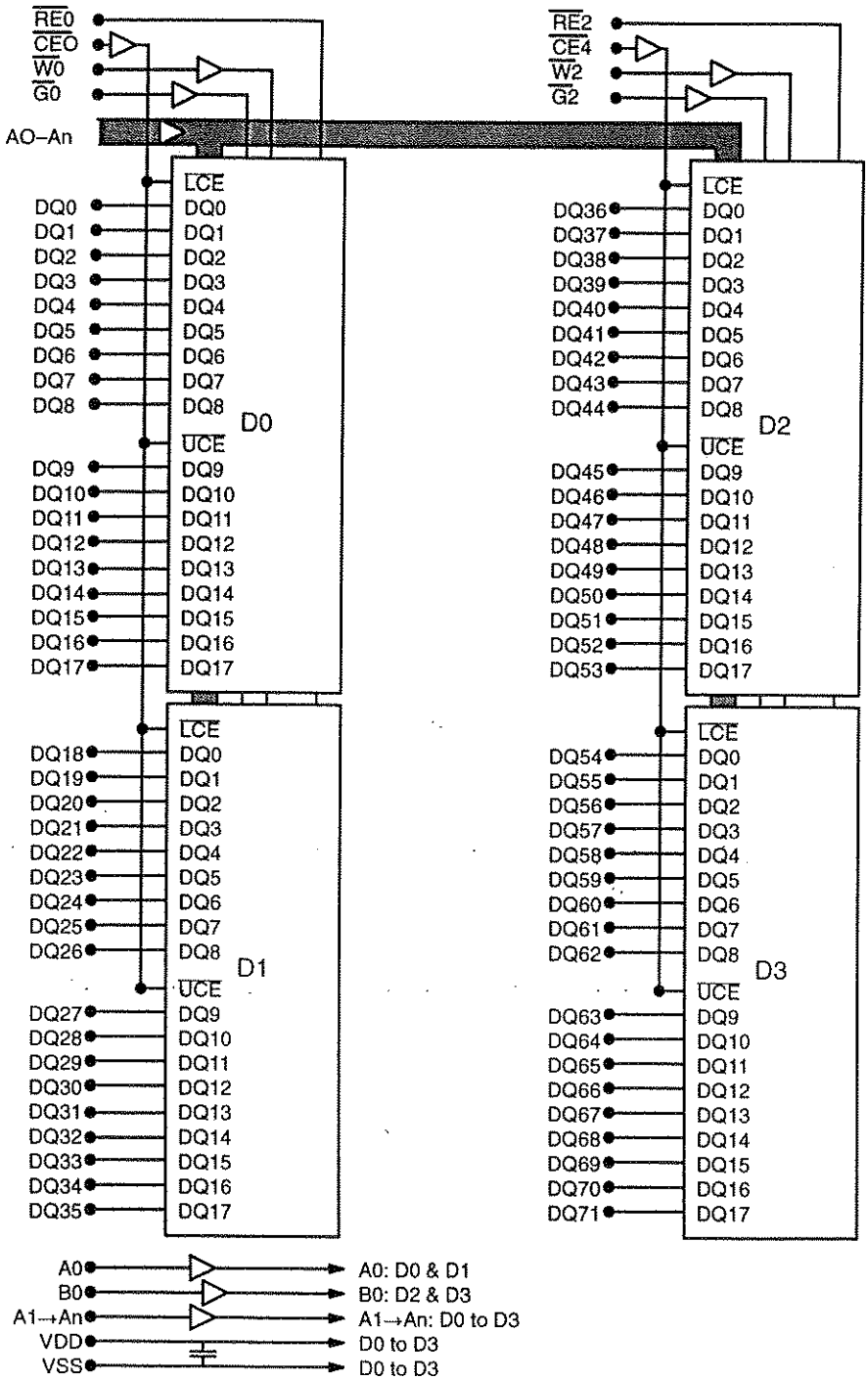



**Figure 4.5.1–S**
**168 PIN, X72 (ECC mode) DRAM DIMM, 1 bank with X18 DRAMs**

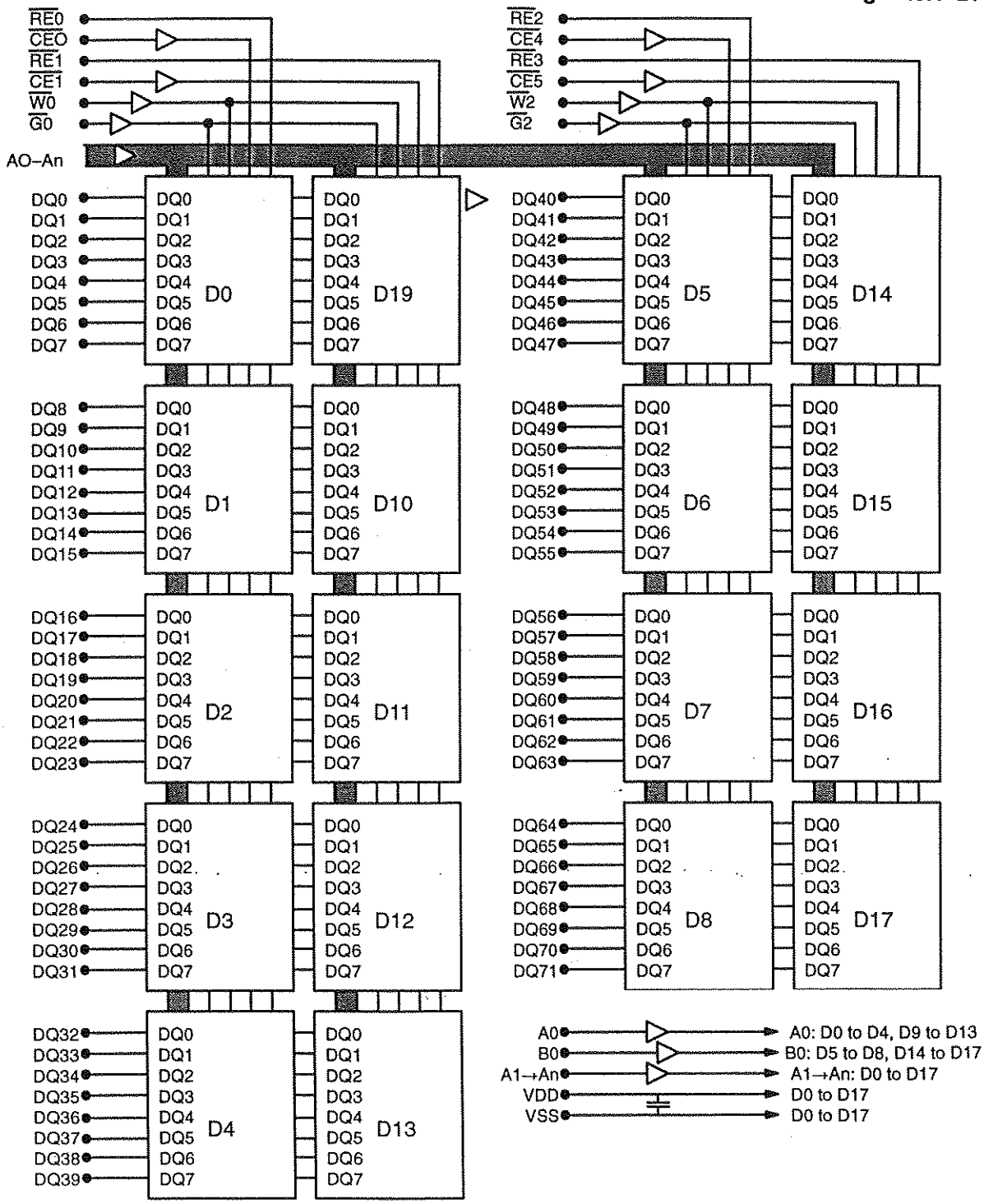



**Figure 4.5.1–T**
**168 PIN, X72 (ECC mode) DRAM DIMM, 2 banks with X8 DRAMs**

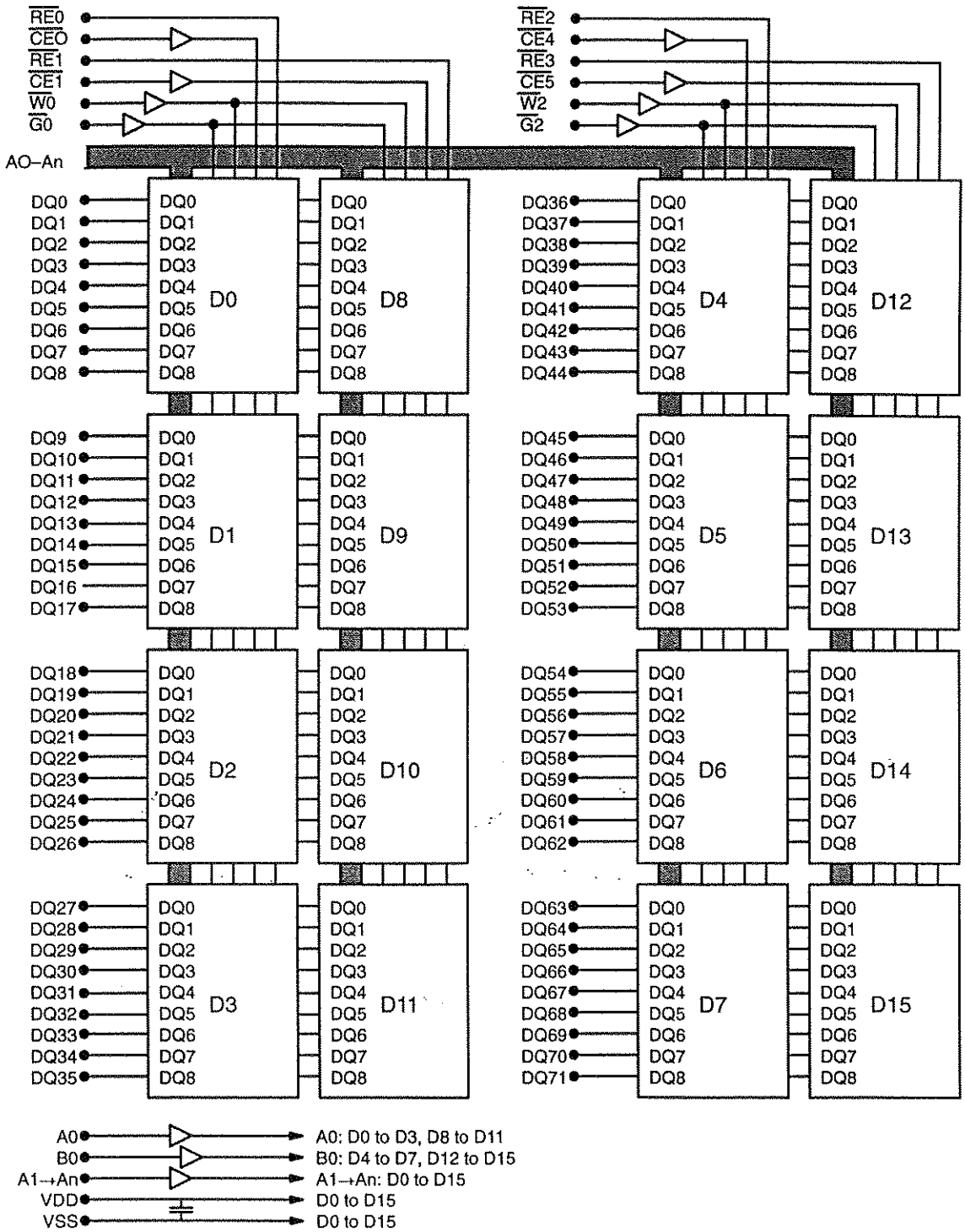



**Figure 4.5.1–U**
**168 PIN, X72 (ECC mode) DRAM DIMM, 2 banks with X9 DRAMs**
**Release 4–7**

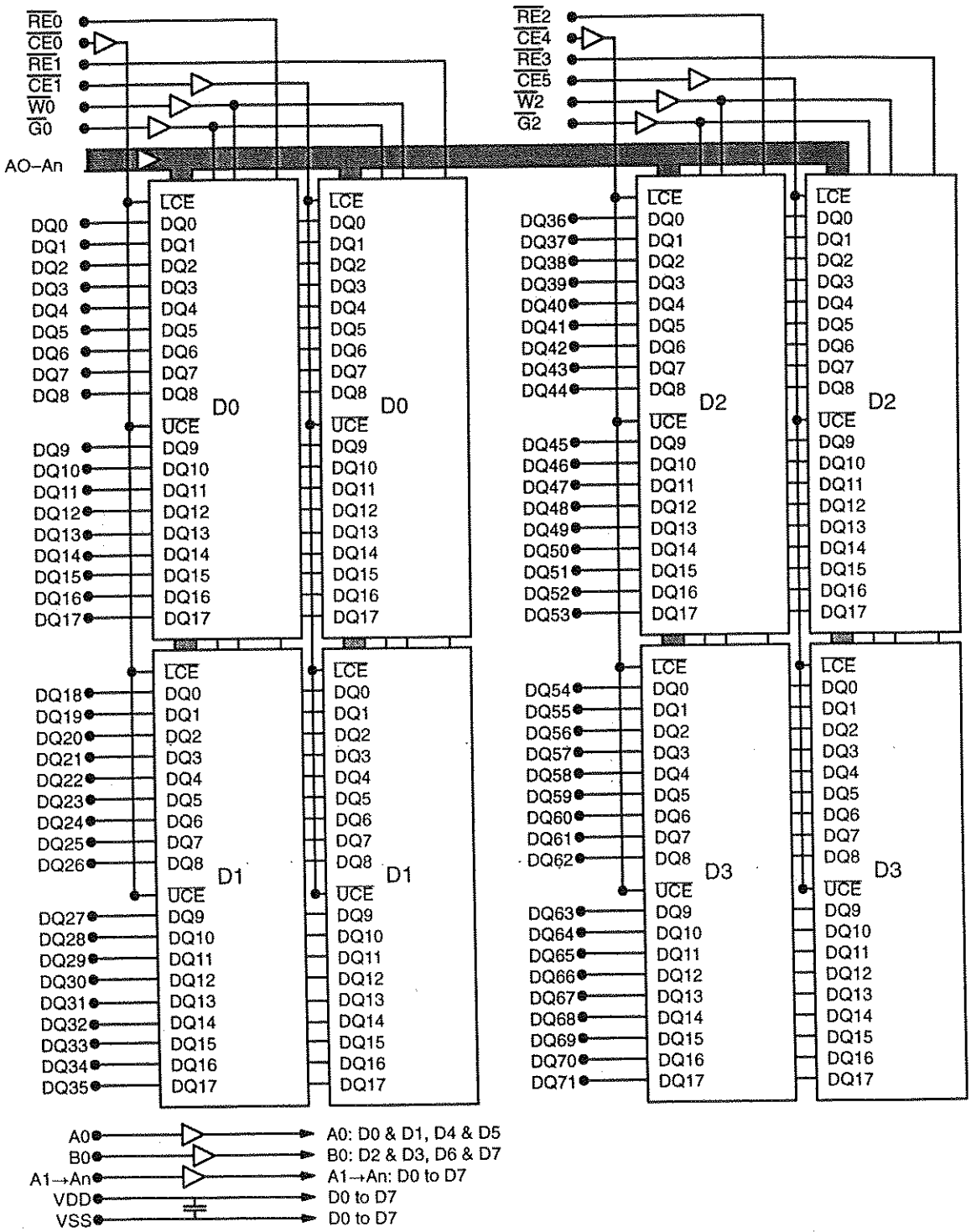



**Figure 4.5.1–V**
**168 PIN, X72 (ECC mode) DRAM DIMM, 2 banks with X18 DRAMs**

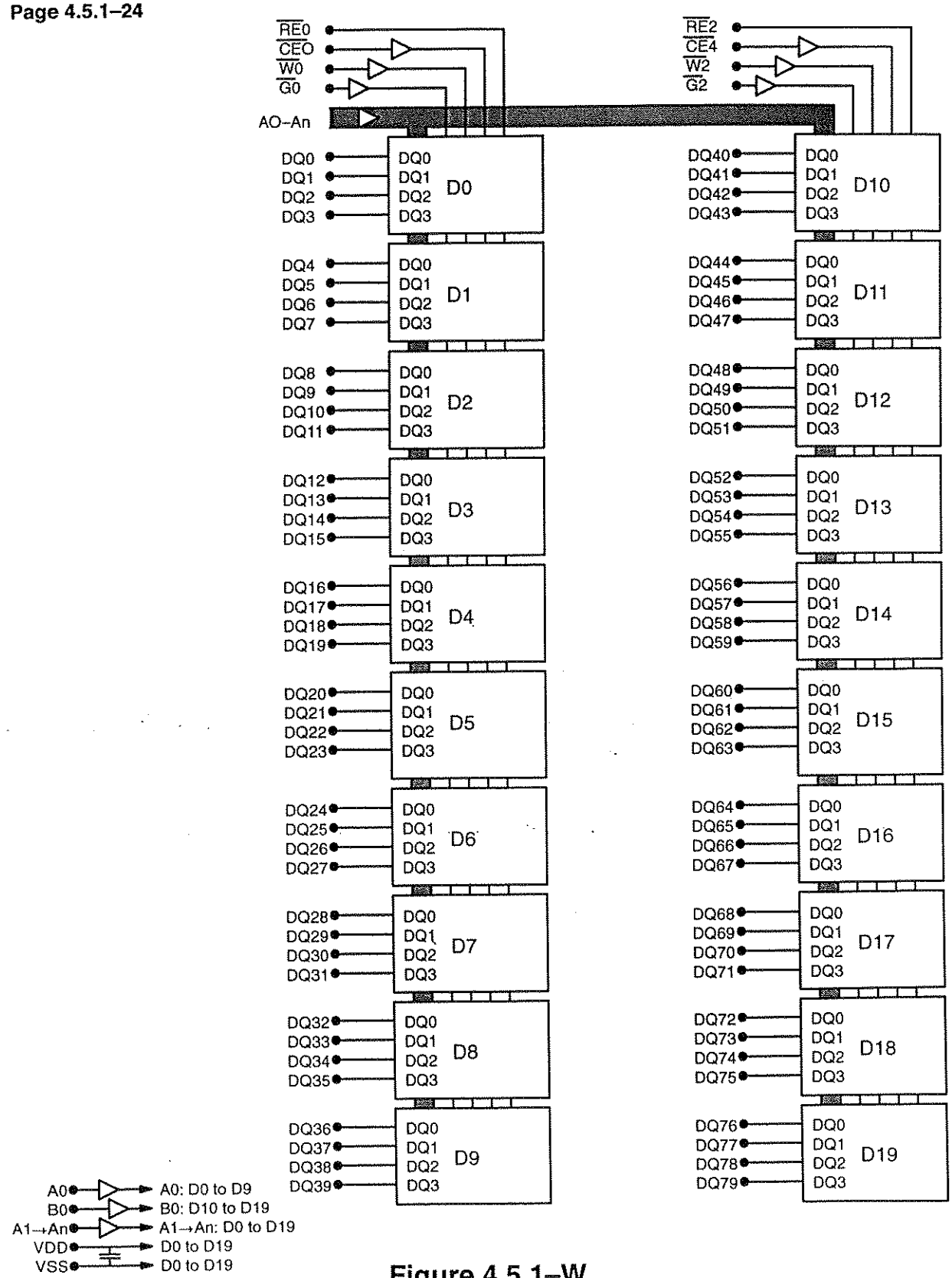



**Figure 4.5.1–W**

**168 PIN, 80 BIT (ECC mode) DRAM DIMM, 1 bank with X4 DRAMs**

Release 4–7

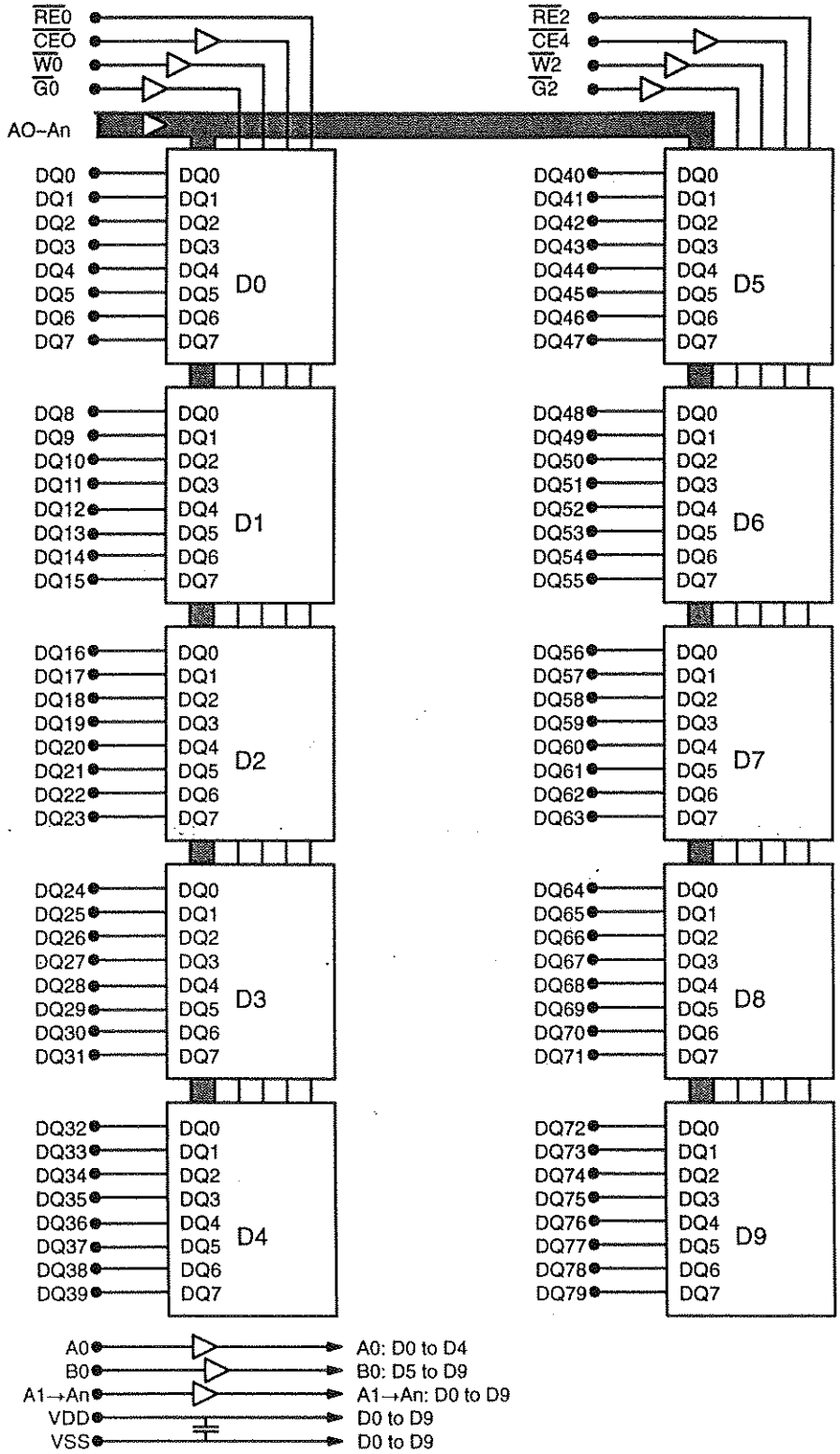



**Figure 4.5.1–X**
**168 PIN, X80 (ECC mode) DRAM DIMM, 1 bank with X8 DRAMs**

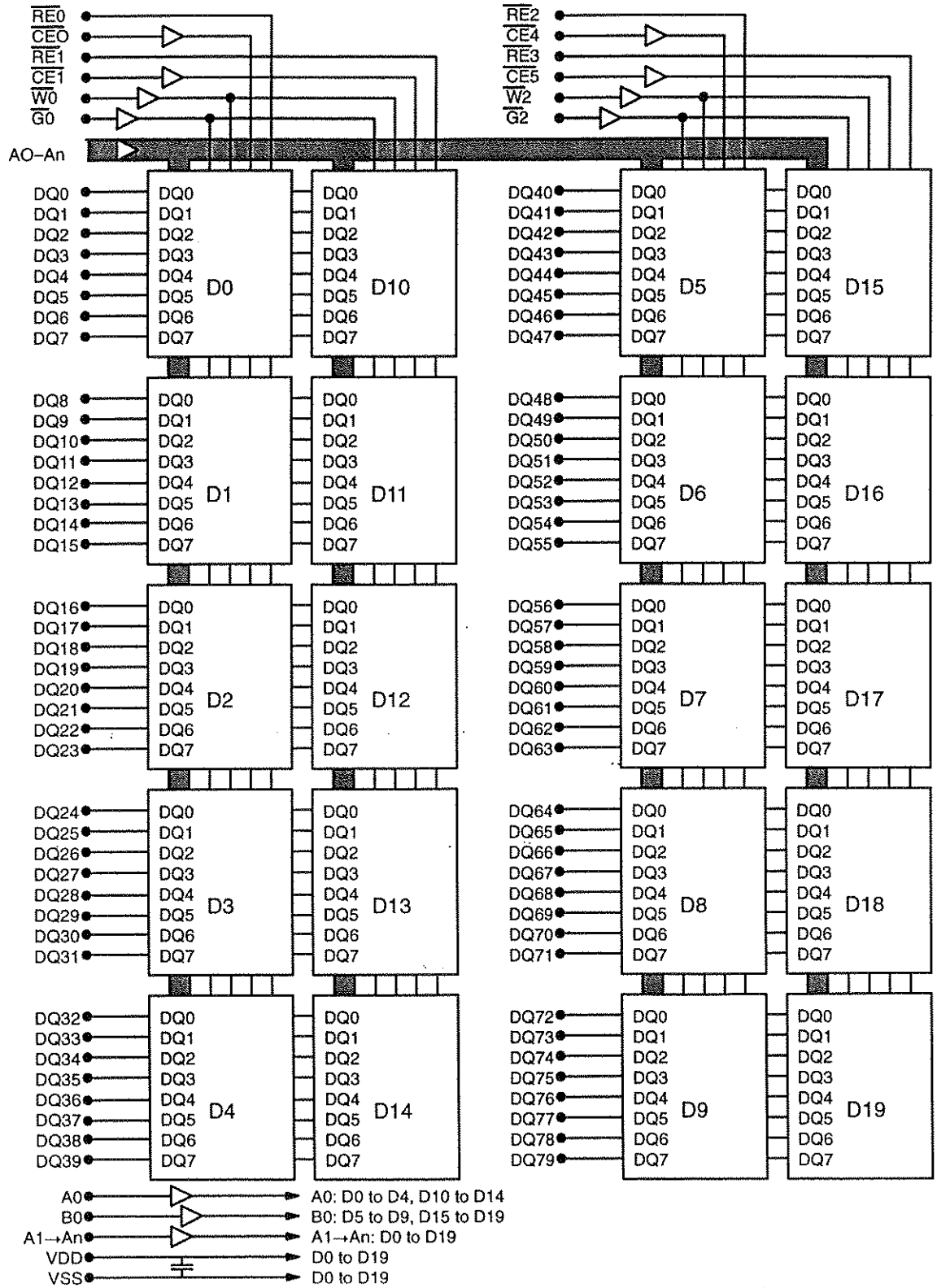



**Figure 4.5.1–Y**
**168 PIN, X80 (ECC mode) DRAM DIMM, 2 banks with X8 DRAMs**

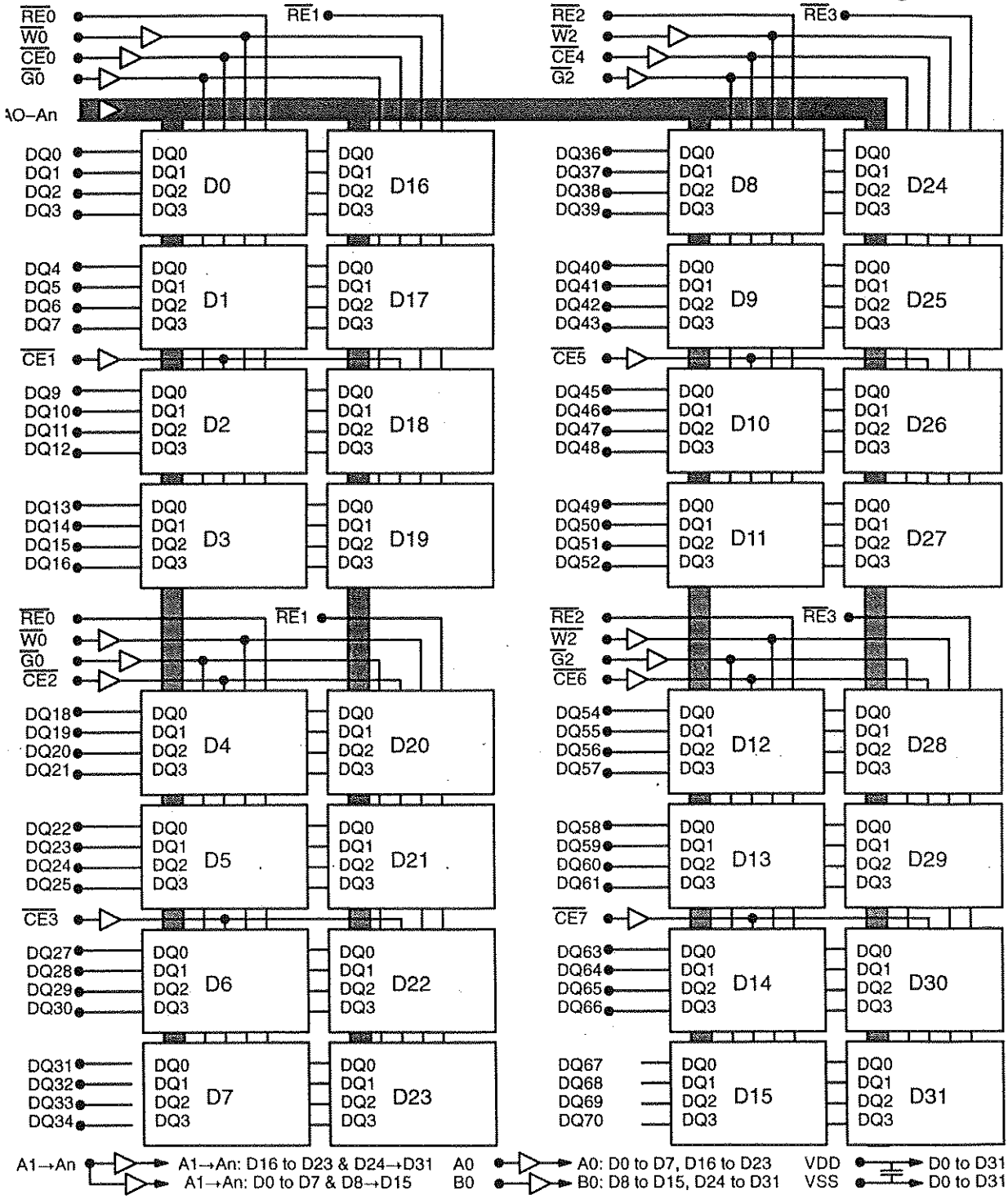



**Figure 4.5.1–Z**
**168 PIN, X64 DRAM DIMM, 2 BANK with X4 DRAMs**

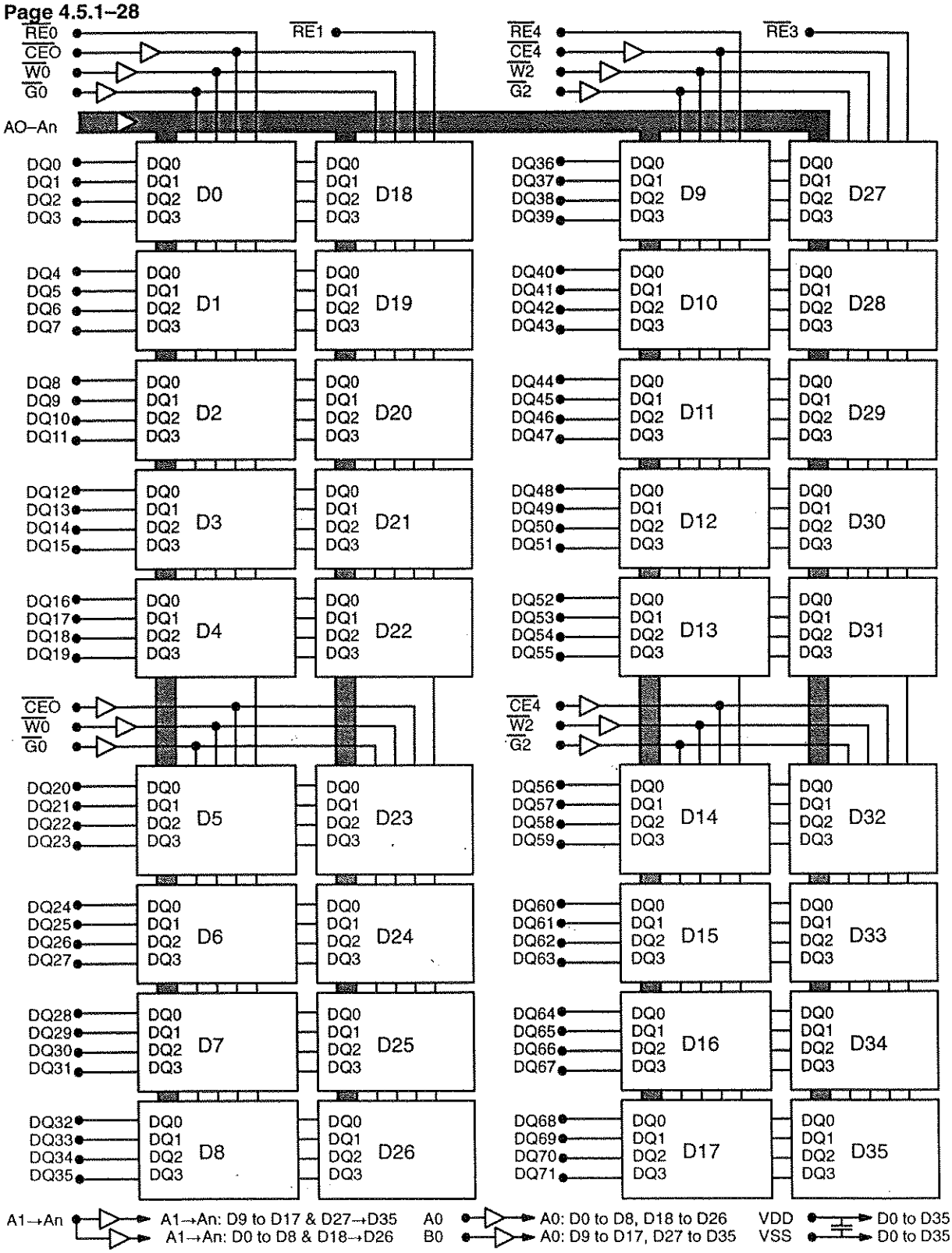



**Figure 4.5.1–AA**
**168 PIN, X72 ECC DRAM DIMM, 2 BANK, X4 DRAMs**
**Release 6c7**

61D

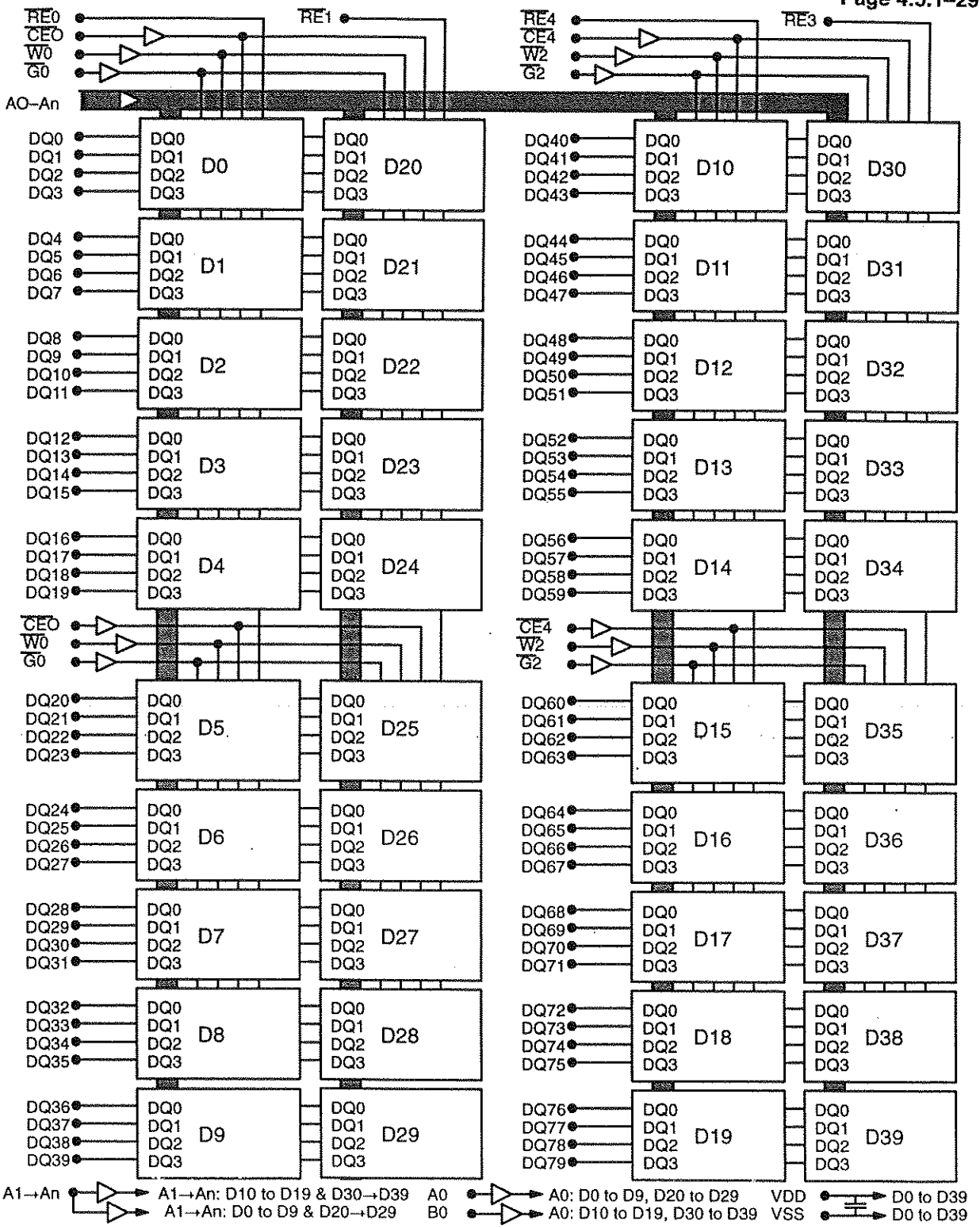



**Figure 4.5.1–AB**
**168 PIN, X80 ECC DRAM DIMM, 2 BANK, X4 DRAMs**

Release 6c7

## 4.5.2 – 200 PIN DRAM DIMM FAMILY

CAPACITY—256K, 512K, 1M, 2M, 4M, 8M, 16M, 32M, & 64M WORDS OF 64, 72, OR 80 BITS

DATA CONFIGURATIONS—Four DATA Word configurations are defined:
—64 BIT without PARITY
—72 BIT for PARITY CODES
—72 BIT & 80 BIT for ECC CODES

CONFIGURATION—21 Different Configurations are defined using various combinationa of X1, X4, X8, X9, X16 and X18 memory devices.

LOGIC FEATURES—The modules contain "PRESENCE DETECT" and "IDENTITY" featurs that conist of output pins in the PDn and IDn fields which supply encoded values that define the storage capacity, configuration, data word configuration, refresh mode, and speed of the module.

PACKAGE—168 PIN JEDEC DIMM MEMORY MODULE

PIN ASSIGNMENTS AND PD TABLES—Figs. 4.5.2–A, 4.5.2–B, & 4.5.2–C

MECHANICAL KEY DEFINITION—Fig. 4.5.2–D

PIN DEFINITIONS—Fig. 4.5.2–E

CONFIGURATION BLOCK DIAGRAM—Figs. 4.5.2–F through 4.5.2–M

XILINX EXHIBIT 1012
Page 346

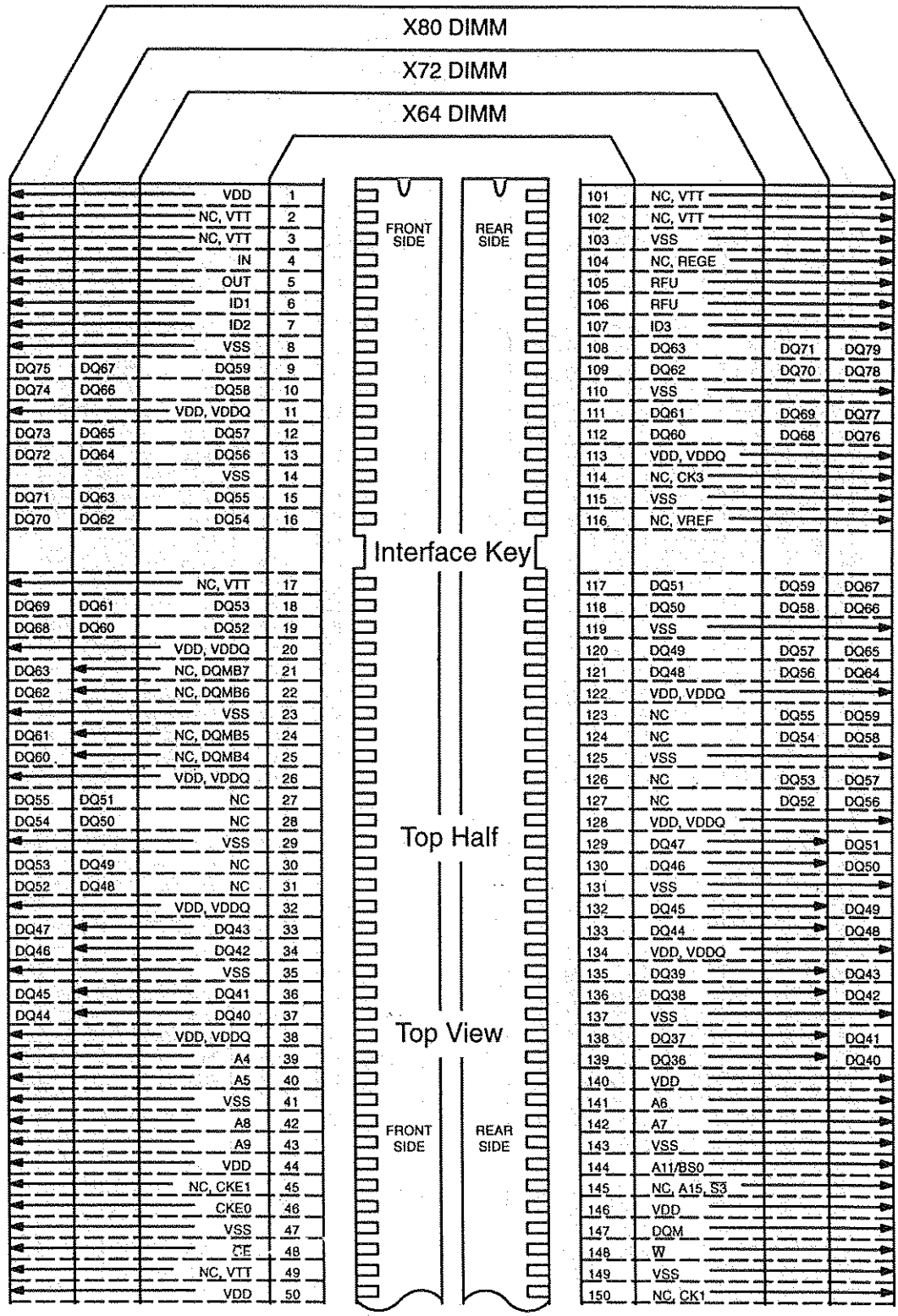



**Figure 4.5.2–A**
**200 PIN, 64, 72, or 80 BIT SDRAM DIMM PINOUT, TOP HALF**

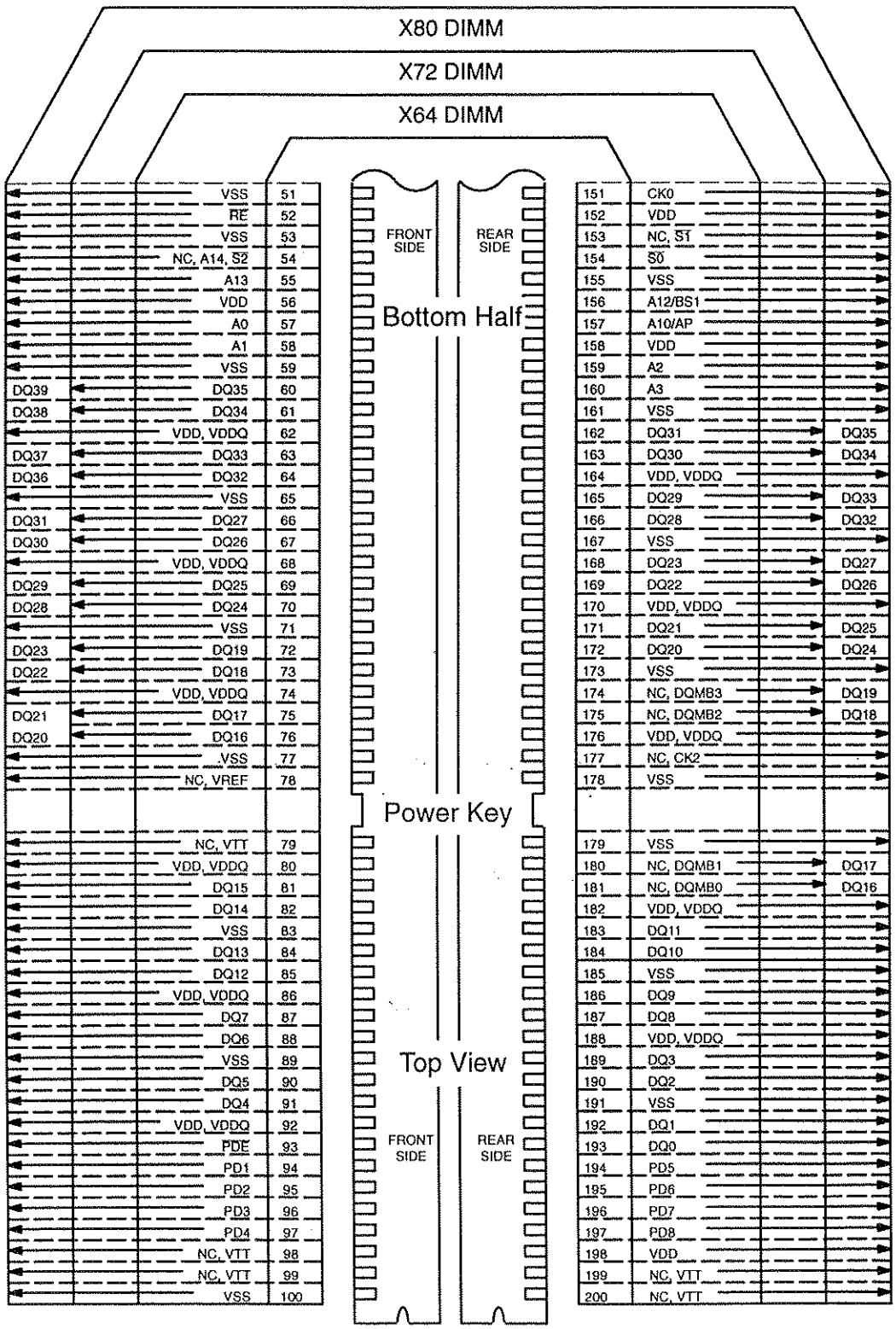



**Figure 4.5.2–B**
**200 PIN, 64, 72, or 80 BIT SDRAM DIMM PINOUT, BOTTOM HALF**

**Release 6–7**

| PD BITS 4 3 2 1 | MODULE CONFIGURATION | SDRAM ORGANIZATION | RE ADDR. | CE ADDR |
|---|---|---|---|---|
| 1 1 1 1 | NO MODULE | | | |
| 1 0 0 0<br>0 0 0 0 | 1M X 64/72/80<br>2M X 64/72/80 | 1M X 16<br>1M X 16 | 12<br>12 | 8<br>8 |
| 1 0 0 1<br>0 0 0 1 | 2M X 64/72/80<br>4M X 64/72/80 | 2M X 8<br>2M X 8 | 12<br>12 | 9<br>9 |
| 1 0 1 0<br>0 0 1 0 | 4M X 64/72/80<br>8M X 64/72/80 | 4M X 4/16<br>4M X 4/16 | 12<br>12 | 10<br>10 |
| 1 0 1 1<br>0 0 1 1 | 8M X 64/72/80<br>16M X 64/72/80 | 8M X 8<br>8M X 8 | TBD<br>TBD | TBD<br>TBD |
| 1 1 0 0<br>0 1 0 0 | 16M X 64/72/80<br>32M X 64/72/80 | 16M X 4<br>16M X 4 | TBD<br>TBD | TBD<br>TBD |
| 1 1 0 1<br>0 1 0 1 | RFU<br>RFU | TBD<br>TBD | TBD<br>TBD | TBD<br>TBD |
| 1 1 1 0<br>0 1 1 0 | RFU<br>RFU | TBD<br>TBD | TBD<br>TBD | TBD<br>TBD |
| 0 1 1 1 | Expansion | | | |

Note 1 Presence Detect pins PD1—PD8 are buffered and enabled by $\overline{PDE}$. The "1" outputs are NC and the "0" outputs are driven low by on–module drivers when $\overline{PDE}$ is asserted active low.

Note 2 Buffered DIMMs (PD7=1) with PD8=0 (Byte–Write) shall be capable of both Word–Write and Byte–Write operations

| | PD6 | PD5 |
|---|---|---|
| SPEED (tCYC) | 195 | 194 |
| 15 ns | 1 | 1 |
| 12 ns | 1 | 0 |
| 10 ns | 0 | 1 |
| 8 ns | 0 | 0 |
| **PD SPEED TABLE** | | |

| | PD7 |
|---|---|
| INTERFACE | 196 |
| UNBUFFERED | 0 |
| BUFFERED | 1 |
| **MODULE INTERFACE** | |

| | PD8 |
|---|---|
| WRITE MODE | 197 |
| BYTE | 0 |
| WORD | 1 |
| **WRITE MODE DETECT** | |

| | ID3 |
|---|---|
| POWER | 107 |
| NORMAL | 0 |
| LOW–POWER | 1 |
| **POWER LEVEL DETECT** | |

| | ID2 |
|---|---|
| RAS TIMING | 7 |
| NO EARLY RAS | 0 |
| EARLY RAS | 1 |
| **READ PRECHARGE TIMING** | |

| | ID1 |
|---|---|
| INTERVAL | 6 |
| 2 CLOCKS | 0 |
| 1 CLOCK | 1 |
| **COMMAND INTERVAL** | |

**Figure 4.5.2–C**

**200 PIN, 64, 72, or 80 BIT SIMM PRESENCE DETECT & CONFIGURATION TABLES**

**Release 5–7**

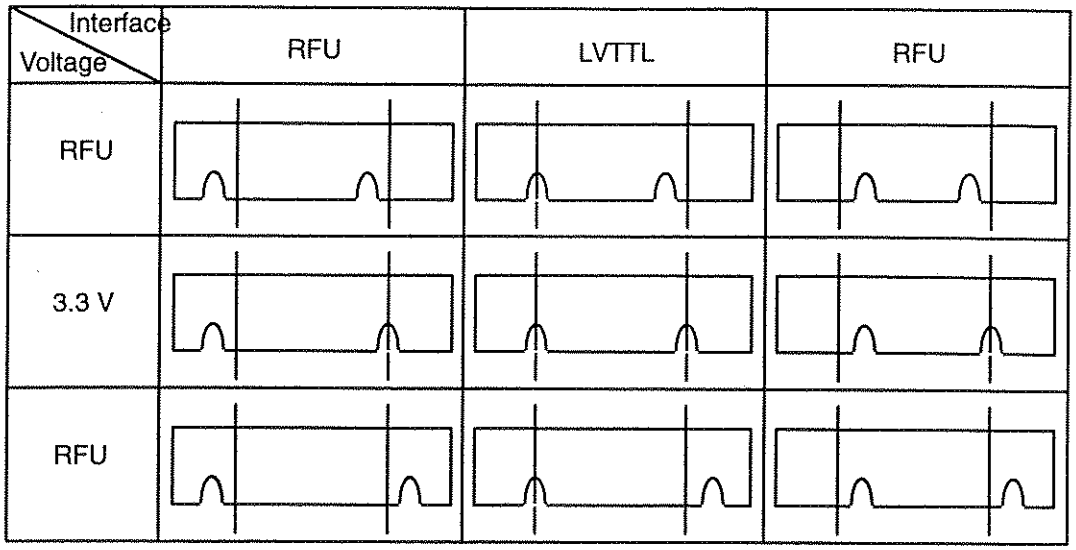



**Figure 4.5.2–D**

**200 PIN, 8 BYTE SDRAM DIMM MECHANICAL KEY DEFINITION**

| Pin Name | Number | Function |
|---|---|---|
| A0....A15 | 16 | Address Input (multiplexed) |
| DQ0....DQ79 | 80 | Data Input/Output (common) |
| CK0....CK3 | 4 | Clock Input |
| CKE0....CKE1 | 2 | Clock Enable Input |
| $\overline{S0}$....$\overline{S3}$ | 4 | Chip Select Input |
| $\overline{RE}$ | 1 | Row Enable (RAS) Input |
| $\overline{CE}$ | 1 | Column Enable (CAS) Input |
| $\overline{W}$ | 1 | Write Enable Input |
| DQM | 1 | Data Mask |
| DQMB0....DQMB7 | 8 | Byte Data Mask |
| REGE | 1 | Buffer/Register Enable |
| $\overline{PDE}$ | 1 | Presence Detect Enable |
| PD1....PD8 | 8 | Buffered Logic Presence Detect Output |
| ID1....ID3 | 3 | Identification Output |
| IN, OUT | 2 | Unbuffered Physical Detect Input/Output |
| VDD | 9 | Primary Positive Power Supply |
| VDDQ | 20 | Posivite Power for Input/Output |
| VREF | 2 | Reference Power Supply |
| VSS | 33 | Ground |
| VTT | 11 | Termination Power Supply |
| RFU | 2 | Reserved for Future Use |

Notes:

1. Pin A14 is shared with S2, and pin A15 is shared with pin S3.
2. Pins DQMB0...DQMB7 are shared with pins defined as NC for X64 and X72 configurations.
3. REGE (Register Enable) operates similarly to the SAB pin on the 74AC11652 "Octal Bus Transceiver and Register with 3–State Outputs". When it is asserted, active high, the buffer–register operates in Register mode, as opposed to when it is de–asserted, inactive low, the buffer –register operates in "real–time" buffer mode.
4. The unbuffered physical detect pins IN and OUT are shorted together on the DIMM.

**Figure 4.5.2–E**

**8 BYTE SDRAM DIMM PIN DEFINITIONS**

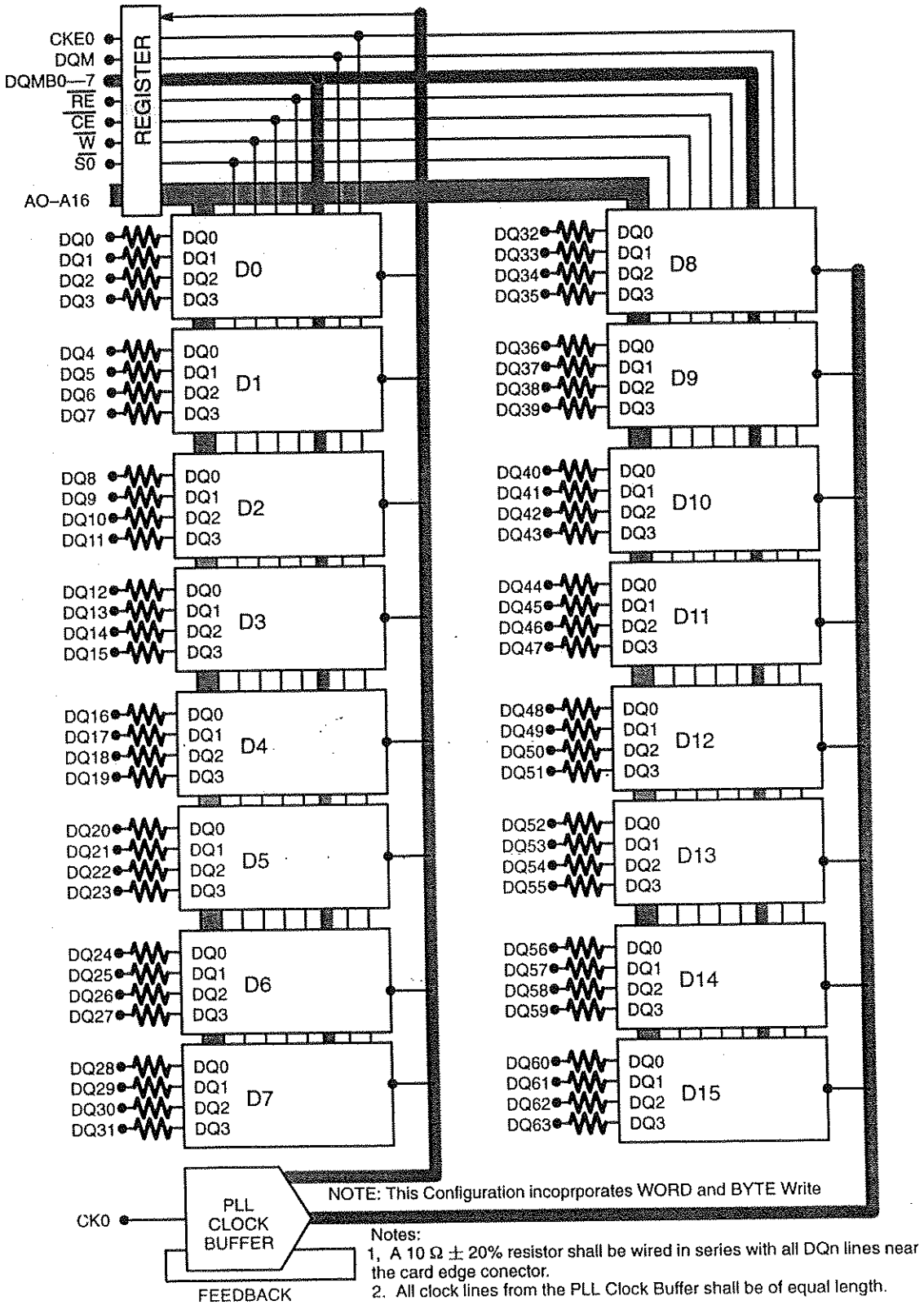
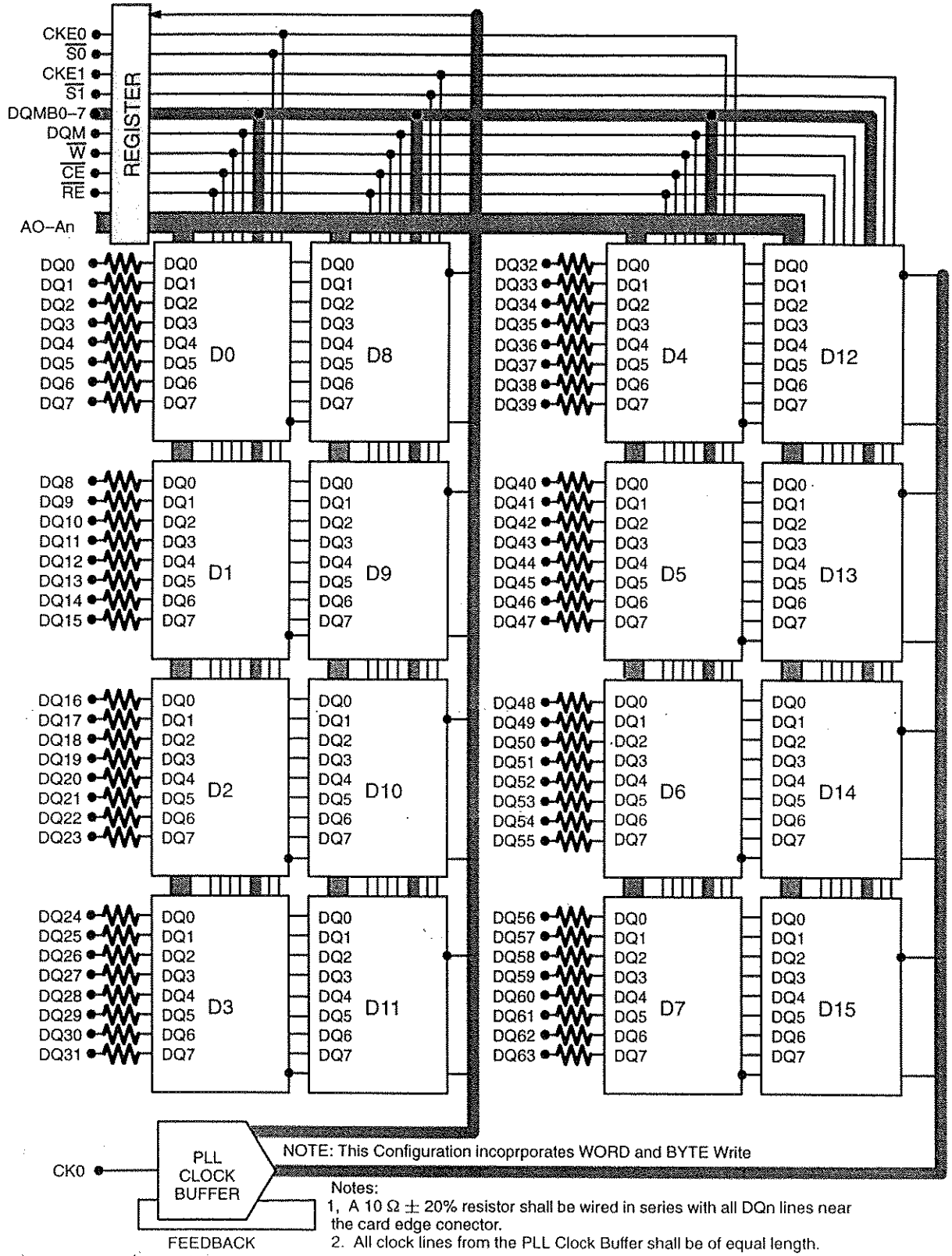



**Figure 4.5.2–F**

**200 PIN, X64 BUFFERED SDRAM DIMM, 1 bank with X4 SDRAMs**



XILINX EXHIBIT 1012
Page 351




Notes:
1, A 10 Ω ± 20% resistor shall be wired in series with all DQn lines near the card edge conector.
2. All clock lines from the PLL Clock Buffer shall be of equal length.

**Figure 4.5.2–G**

**200 PIN, X64 BUFFERED SDRAM DIMM, 2 BANKS with X8 SDRAMs**

**Release 5–7**

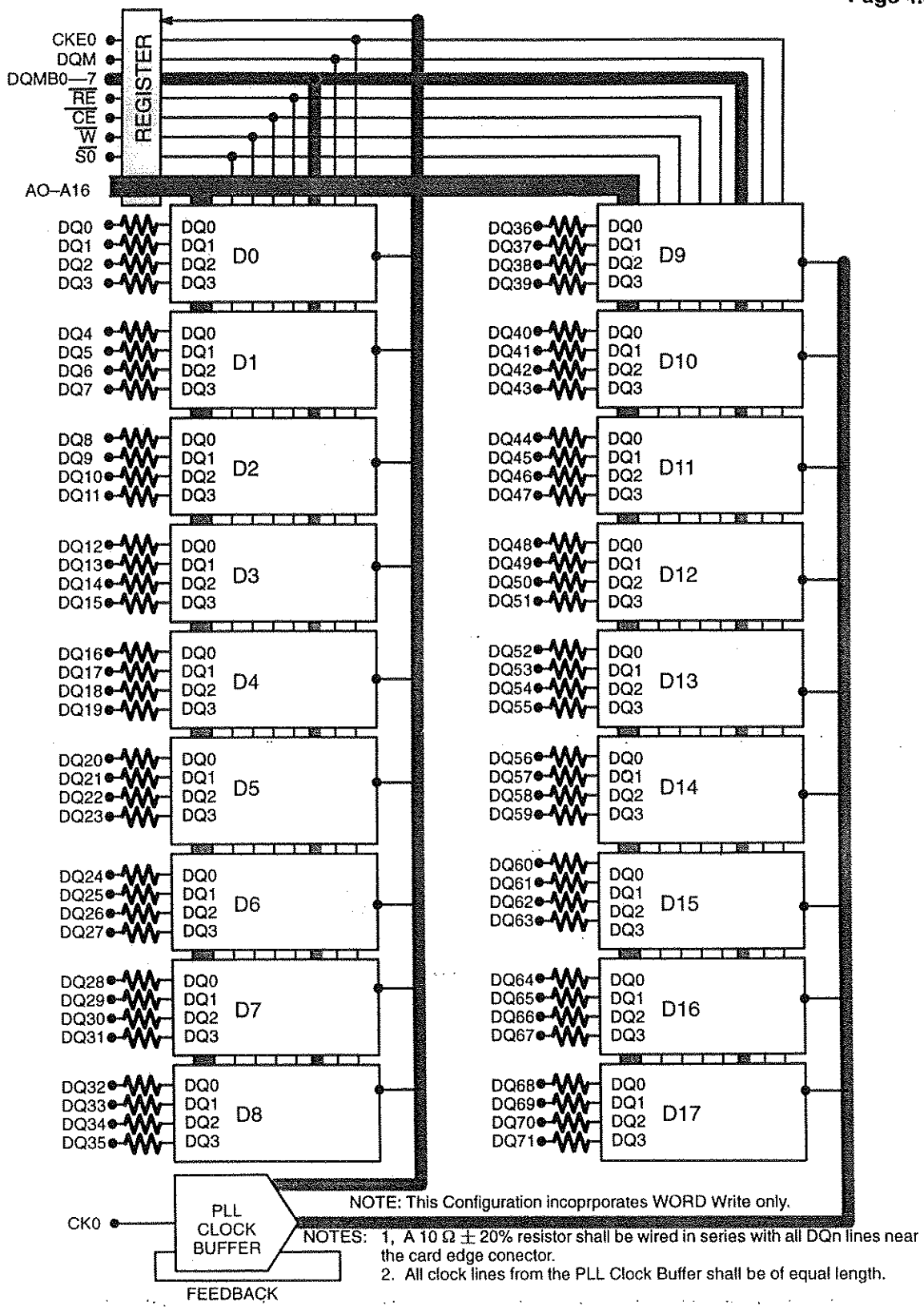
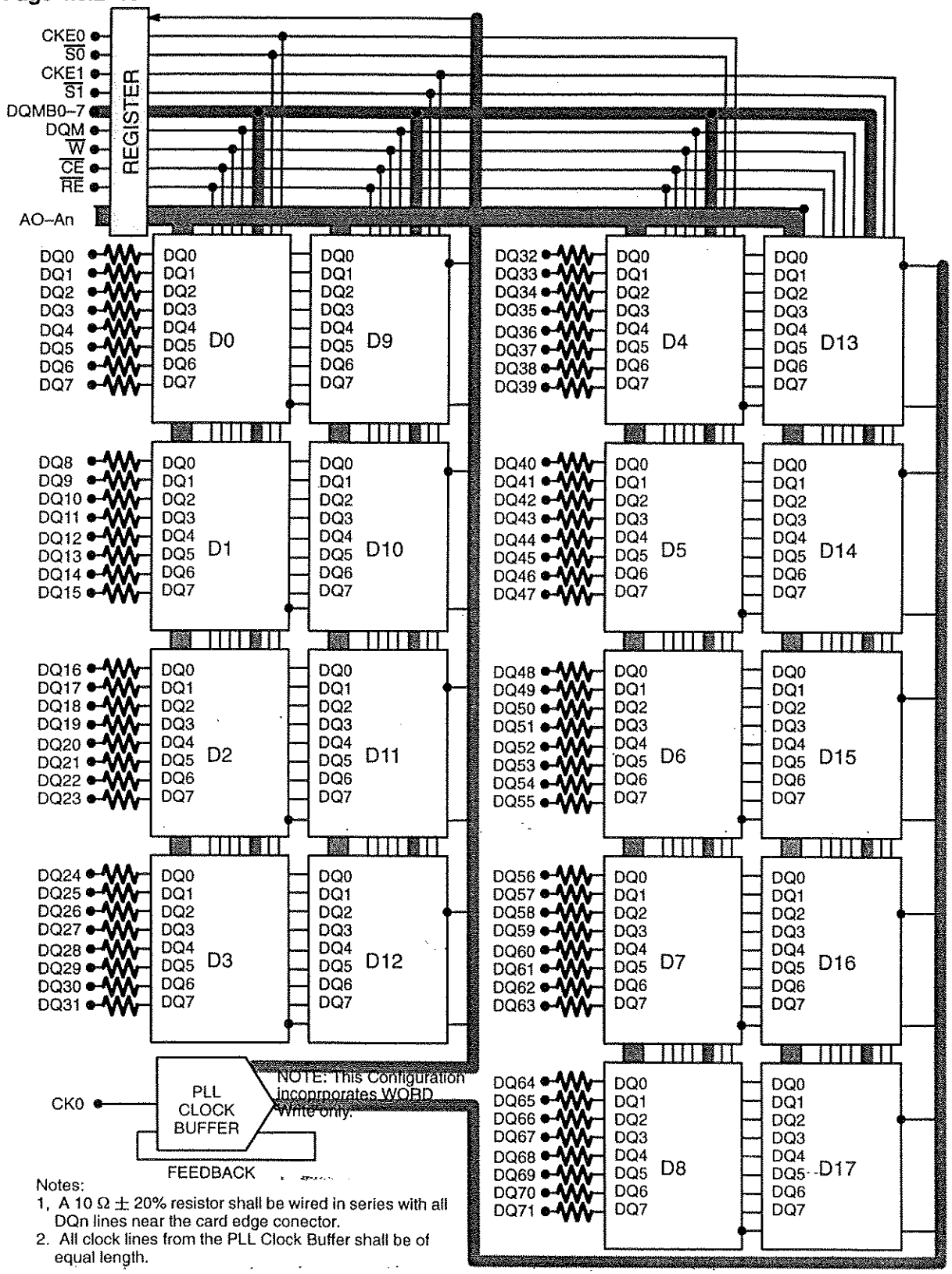



**Figure 4.5.2–H**

**200 PIN, X72 BUFFERED SDRAM DIMM, 1 bank with X4 SDRAMs**




Notes:
1. A 10 Ω ± 20% resistor shall be wired in series with all DQn lines near the card edge conector.
2. All clock lines from the PLL Clock Buffer shall be of equal length.

**Figure 4.5.2–I**

**200 PIN, X72 BUFFERED SDRAM DIMM, 2 BANKS with X8 SDRAMs**

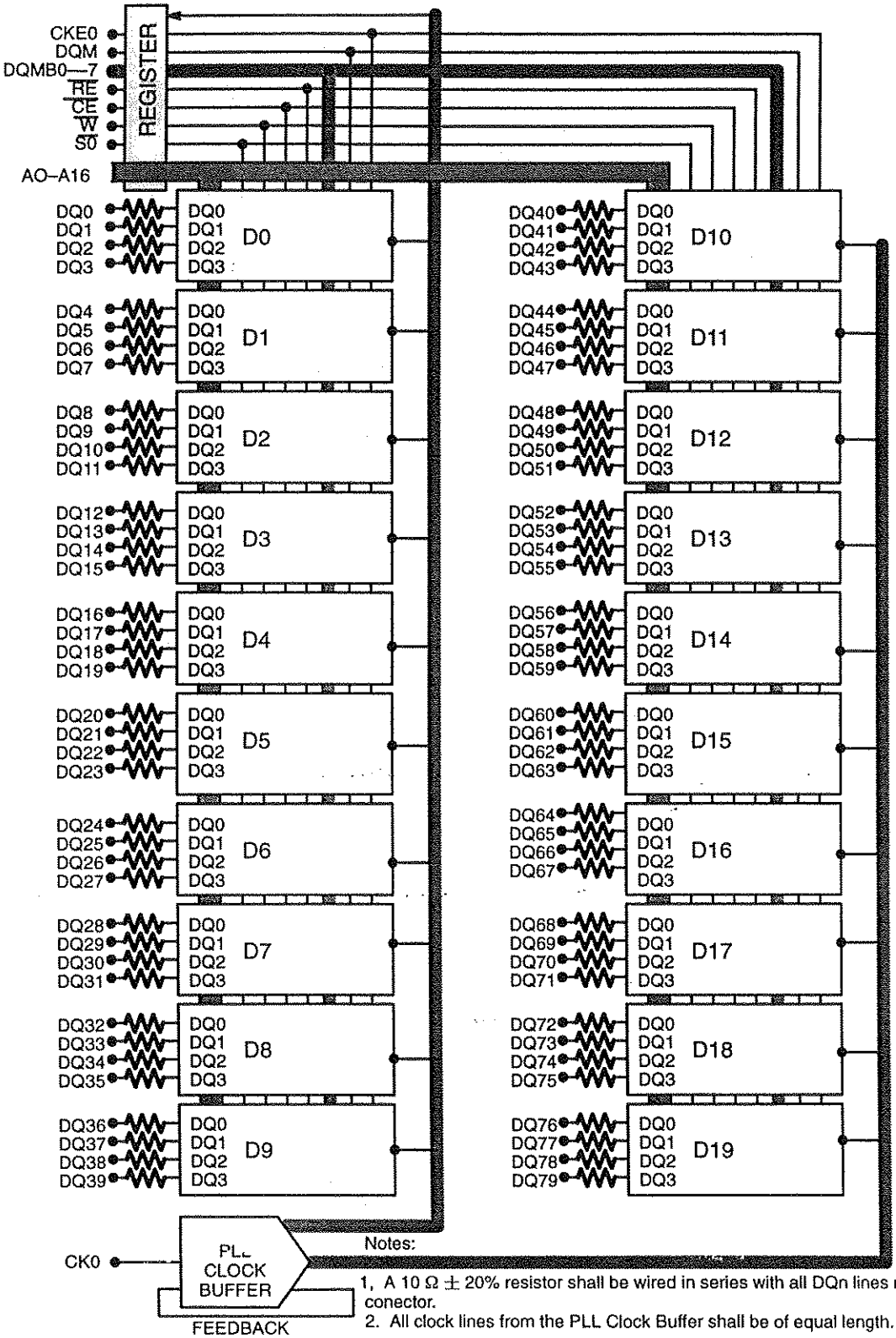
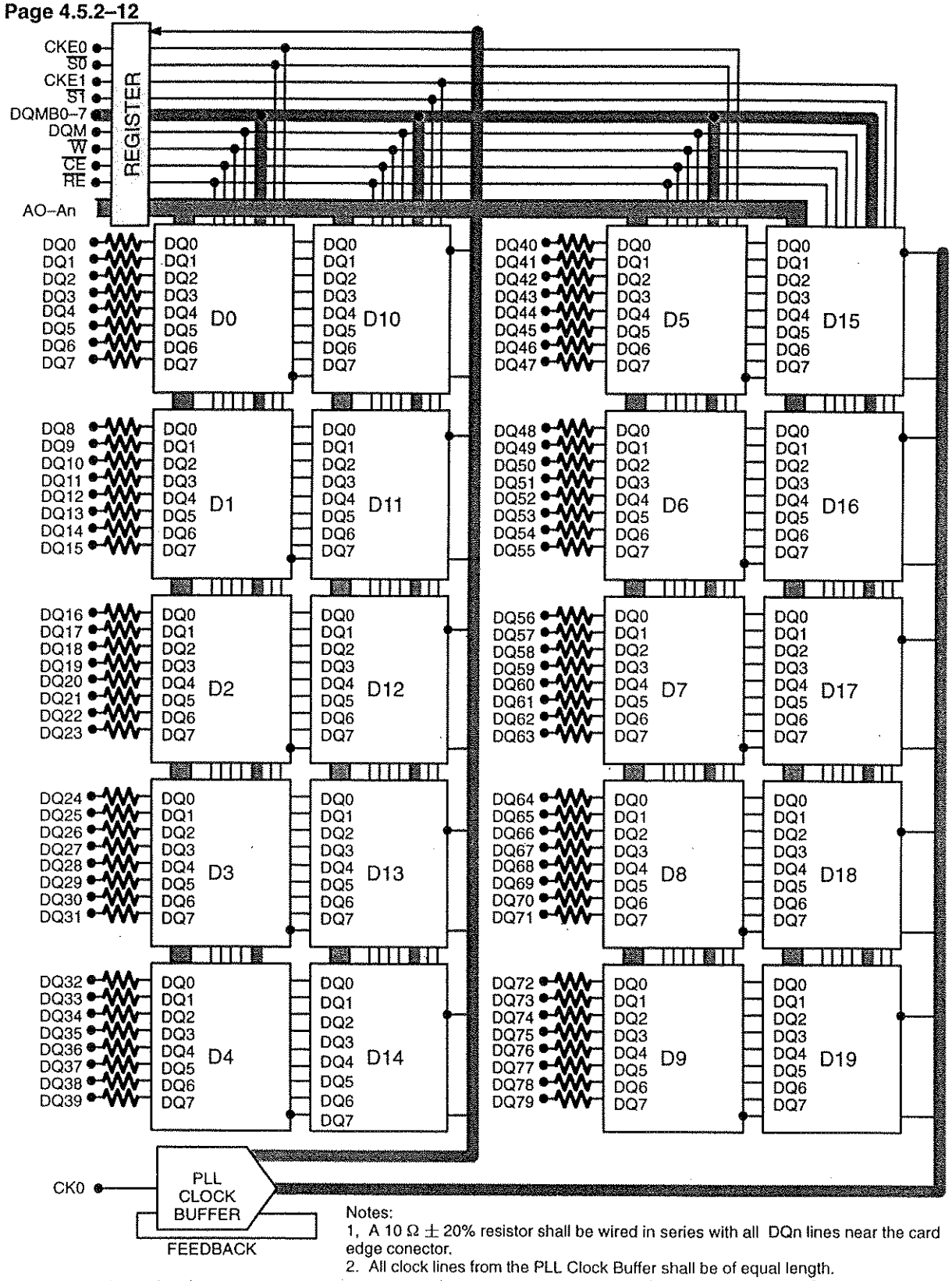



**Figure 4.5.2–J**

**200 PIN, X80 BUFFERED SDRAM DIMM, 1 bank with X4 SDRAMs**

**Release 5–7**

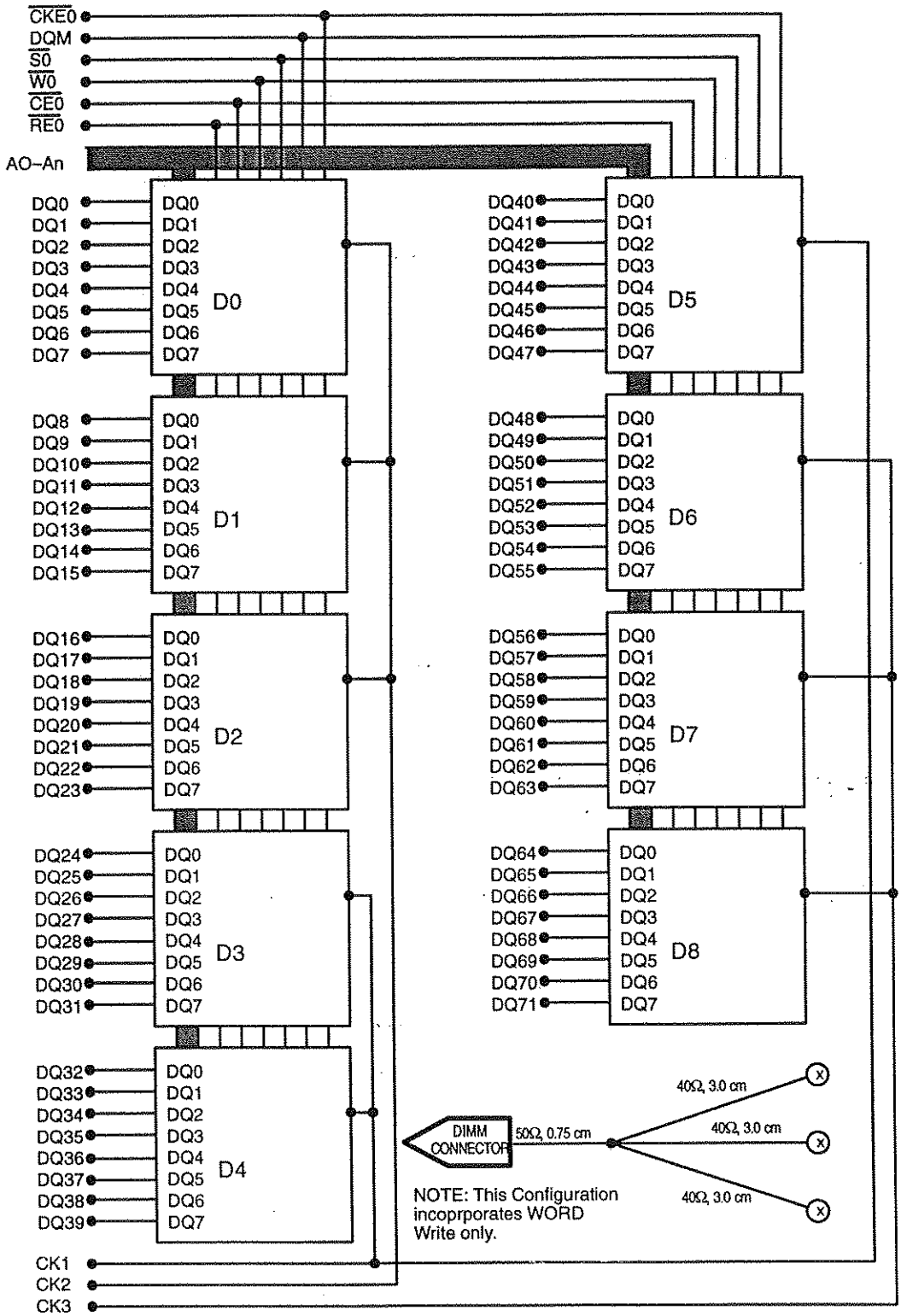



Notes:
1, A 10 Ω ± 20% resistor shall be wired in series with all DQn lines near the card edge conector.
2. All clock lines from the PLL Clock Buffer shall be of equal length.

**Figure 4.5.2–K**

**200 PIN, X80 BUFFERED SDRAM DIMM, 2 BANKS with X8 SDRAMs**

**Release 5–7**




Note: All clock trees shall be routed as equal–length "stars" from CK1, CK2, & CK3 inputs as shown in the diagram above.

**Figure 4.5.2–L**

**200 PIN, X72 UNBUFFERED SDRAM DIMM, 1 bank with X8 DRAMs**

**Release 5–7**

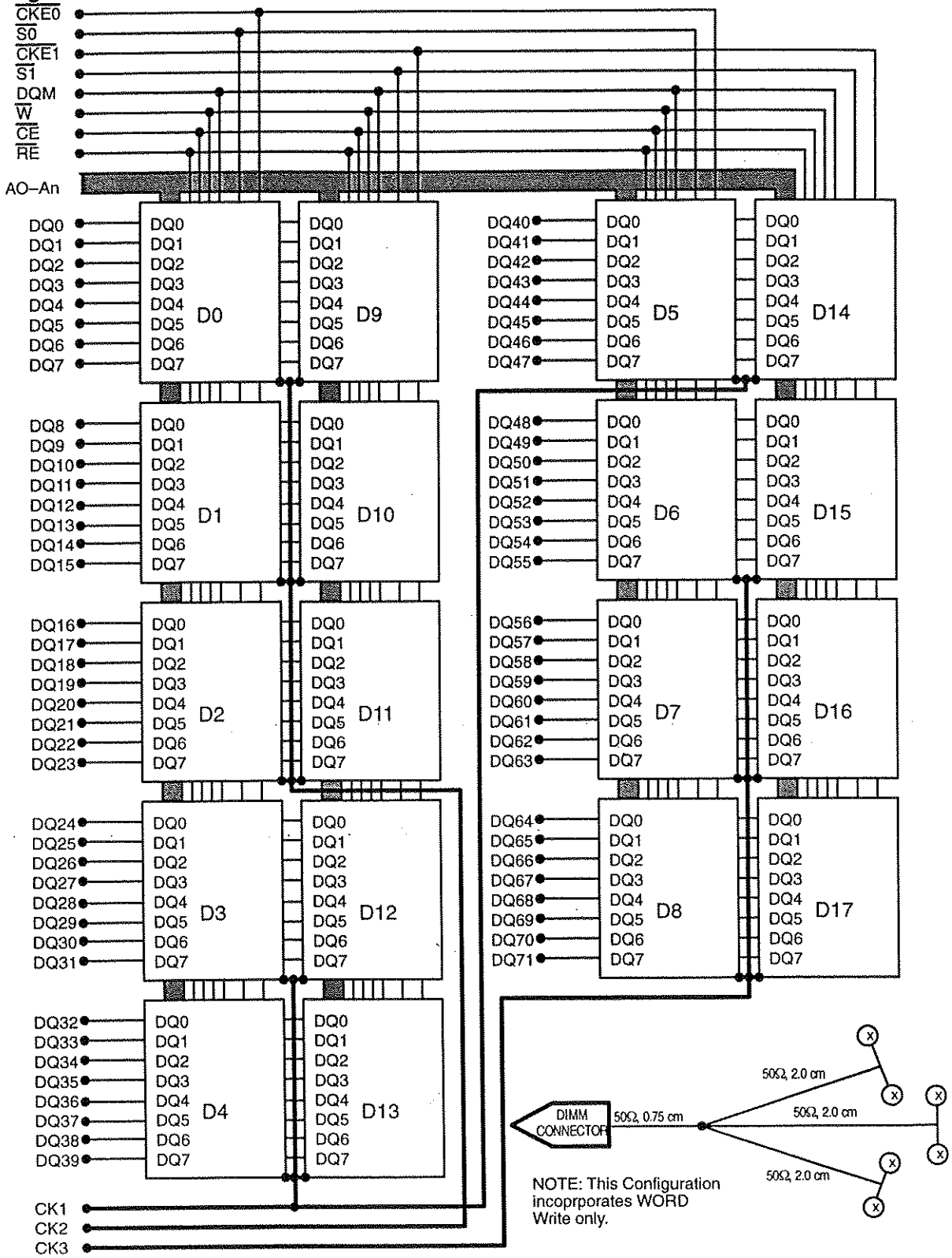



**Figure 4.5.2–M**

**200 PIN, X72 UNBUFFERED SDRAM DIMM, 2 banks with X8 DRAMs**

**Release 5–7**

## 4.5.3 – 168 PIN UNBUFFERED DRAM DIMM FAMILY

CAPACITY—256K, 512K, 1M, 2M, 4M, 8M, 16M, 32M, & 64M WORDS OF 64, 72, OR 80 BITS

DATA CONFIGURATIONS—Four DATA Word configurations are defined:
—64 BIT without PARITY
—72 BIT for PARITY CODES
—72 BIT & 80 BIT for ECC CODES

CONFIGURATION—13 Different Configurations are defined using various combinationa of X1, X4, X8, X16 and X18 memories.

LOGIC FEATURES—The modules contain "SERIAL PRESENCE DETECT" features using EEPROM stored information that profided a variety of encoded information regarding the module such as storage capacity, configuration, data word configuration, refresh mode, and speed of the module.
—Check Bit locations are pre–assigned

PACKAGE—168 PIN JEDEC DIMM MEMORY MODULE

PIN ASSIGNMENTS—Figs. 4.5.3–A, & 4.5.3–B

SPD TABLES—Figs. 4.5.3–C

KEYING METHODOLOGY—Fig. 4.5.3–D

CONFIGURATION BLOCK DIAGRAM—Figs. 4.5.3–E through 4.5.3–S

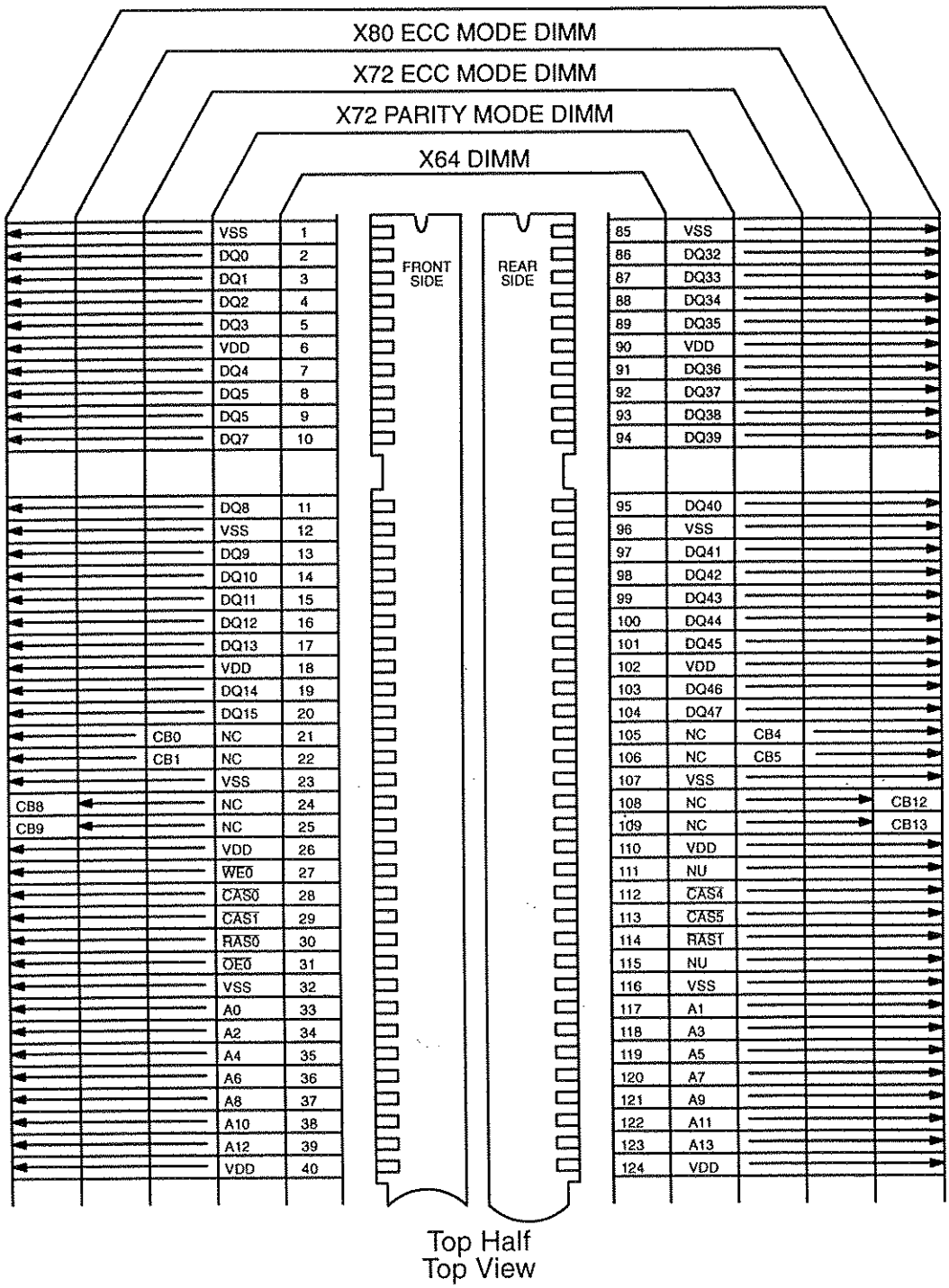



**FIGURE 4.5.3–A**
**64, 72, or 80 BIT DIMM PINOUT, TOP HALF**

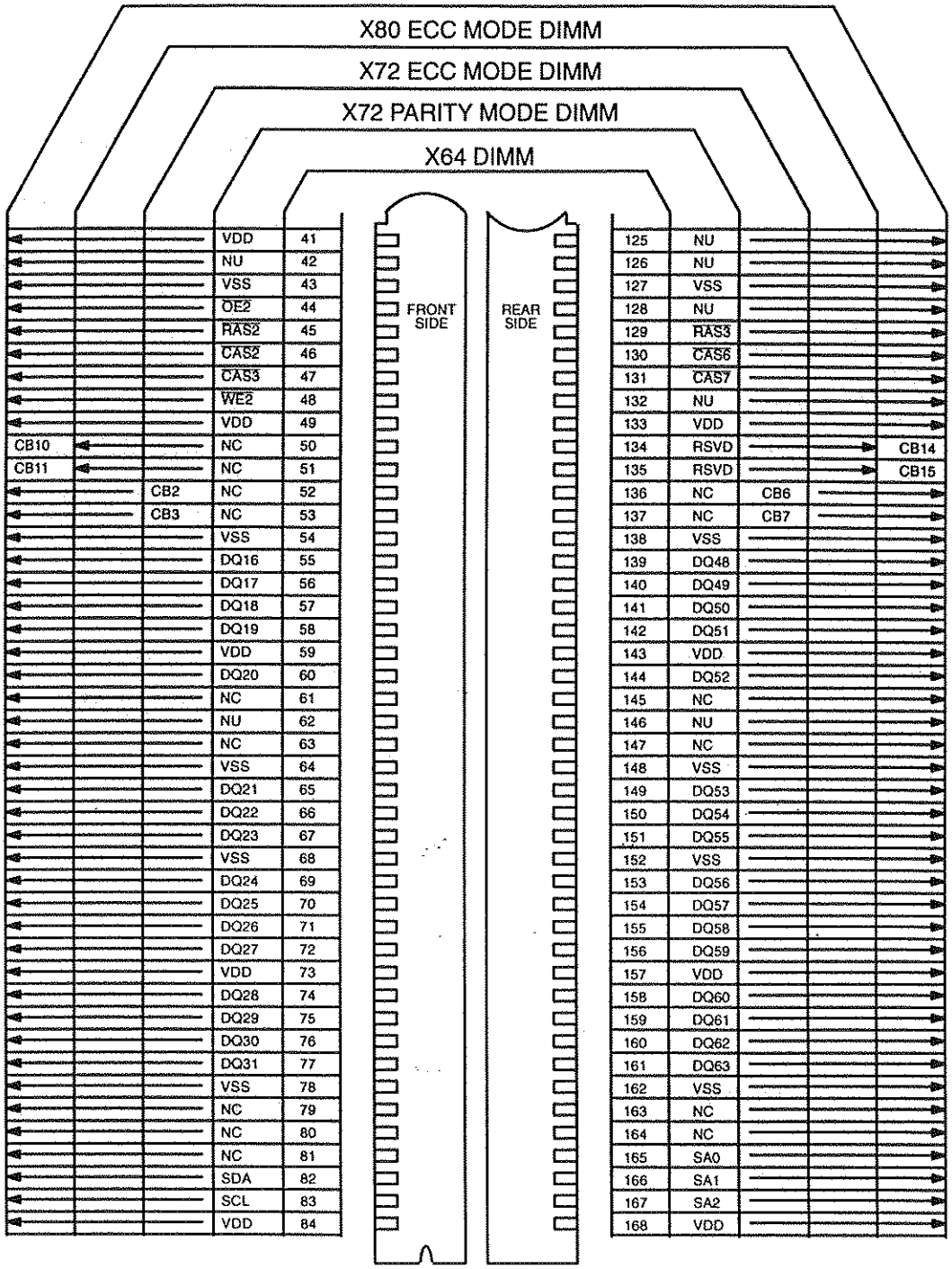


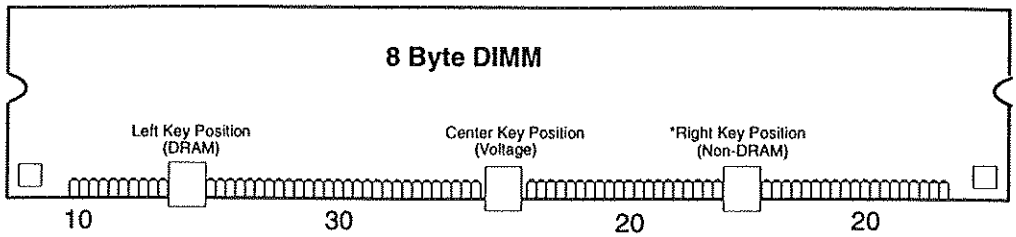

**FIGURE 4.5.3–B**
**64, 72, or 80 BIT DIMM PINOUT, BOTTOM HALF**

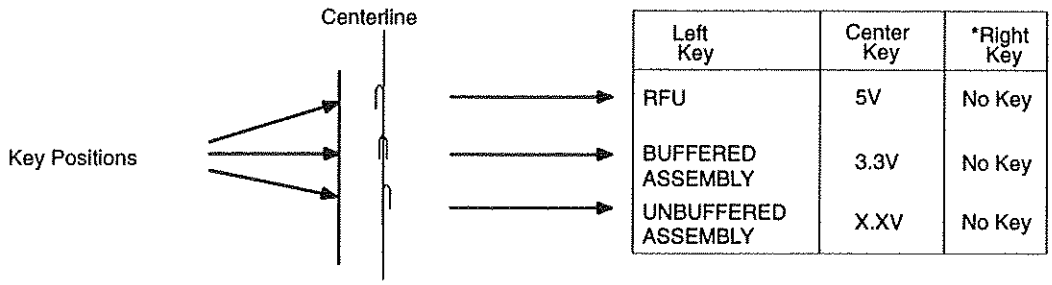
| Buffered | Unbufffered |
|---|---|
| All signals except RAS and Data are buffered | No buffers, all DRAM signals are connected directly to DIMM tab pins |
| 11 Pins are used for DIMM attributes (PDE, PD1-8, ID0-1) | 5 pins are used for DIMM attributes (SDA, SCL, SA0-2) |
| CAS Pin assignment sequence optimized for buffer placement<br>0, 1<br>2, 3<br>4, 5<br>6, 7 | CAS Pin signals are re-assigned for optimal DRAM placement<br>0, 4<br>1, 5<br>2, 6<br>3, 7 |
| ECC DIMMs use subset of CAS signals for word selection (CAS0/1 and CAS4/5) | All DIMM types use byte selection (CAS0-7) |
| Address 0 to the DRAMs is sourced from separate pins (A0, B0) for 4 byte interleave | Single address pin (A0) |
| Data pin assignment uses both X64/X72 and X80 numbering schemes | Data pin assignment is changed to single x80 numbering scheme with x64 and x72 as subsets |
| Non-Parity is subset of Parity with inter-mixed Parity bits unconnected (PQ8, 17, 26, 35, 44, 53, 62, 71) | All DIMM types use the same sequential 64 data pins (DQ0-63).<br><br>Eight center pins (CB0-7) are used as Parity/Check Bits for x72 Parity/ECC DIMMs.<br><br>An additional 8 center pins (CB8-15) are used for the x80 ECC DIMMs. |
| 32 Power/Gnd Pins<br>$V_{CC}$ - 16<br>$V_{SS}$ - 16 | 35 Power/Gnd Pins<br>$V_{CC}$ - 17 (1 additional pin)<br>$V_{SS}$ - 18 (2 additional pins) |
| Unused Pins - 18 | Unused Pins - 14 |
| Left Key Definition<br>SDRAM<br>STD DRAM<br>RFU | Left Key Definition modified<br>RFU<br>Buffered Assembly (DRAM/SDRAM)<br>Unbuffered Assembly (DRAM/SDRAM) |

## FIGURE 4.5.3–C
## Comparison of 168 Pin Buffered & Unbuffered DRAM & SDRAM DIMM



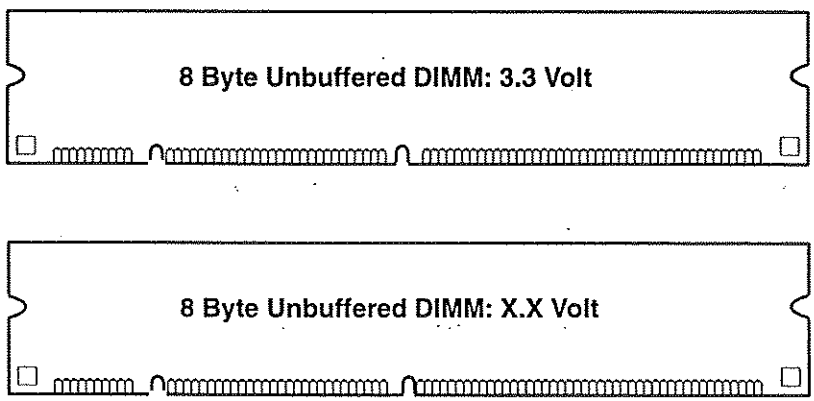
XILINX EXHIBIT 1012
Page 362




| Left Key | Center Key | *Right Key |
|---|---|---|
| RFU | 5V | No Key |
| BUFFERED ASSEMBLY | 3.3V | No Key |
| UNBUFFERED ASSEMBLY | X.XV | No Key |

* For DRAM/SDRAM assemblies, this area is poplulated with pads.




## FIGURE 4.5.3–D
## 168 Pin DRAM DIMM Keying Methodology

| | | |
|---|---|---|
| 31 | $\overline{OE0}$ | DU |
| | | |
| 42 | DU | CK0 |
| | | |
| 44 | $\overline{OE2}$ | DU |
| 45 | $\overline{RAS2}$ | $\overline{S2}$ |
| 46 | $\overline{CAS2}$ | DQMB2 |
| 47 | $\overline{CAS3}$ | DQMB3 |
| 48 | $\overline{WE2}$ | DU |
| | | |
| 62 | DU | $V_{REF}$ (IF APPLICABLE) |
| | | |
| 111 | DU | $\overline{CAS}$ |
| 112 | $\overline{CAS4}$ | DQMB4 |
| 113 | $\overline{CAS5}$ | DQMB5 |
| 114 | $\overline{RAS1}$ | $\overline{S1}$ |
| 115 | DU | $\overline{RAS}$ |
| | | |
| 125 | DU | CK1 |
| 126 | DU | A14 |
| | | |
| 128 | DU | CKE |
| 129 | $\overline{RAS3}$ | $\overline{S3}$ |
| 130 | $\overline{CAS6}$ | DQMB6 |
| 131 | $\overline{CAS7}$ | DQMB7 |
| 132 | DU | A15 |
| | | |
| 146 | DU | $V_{REF}$ (IF APPLICABLE) |

**Notes:**
1. A10 on DRAM DIMM is also AP on SDRAM DIMM
2. A11 on DRAM DIMM is also BS0 on SDRAM DIMM
3. A12 on DRAM DIMM is also BS1 on SDRAM DIMM (for 4 Bank SDRAMs)

## FIGURE 4.5.3–E
## Pinout Comparison, 168 Pin DRAM & SDRAM DIMM



XILINX EXHIBIT 1012
Page 364

# 8 Byte Presence Detect Information

- Serial PD Interface Protocol: IIC (Synchronous 2-Wire Bus)
- The following information is to be written into EEPROM device during module production:

a. Module Configurations, Addressing: (Bytes 3-7)

| Module Configuration | DRAM Organization | Option 1 | | Option 2 | | Option 3 | |
|---|---|---|---|---|---|---|---|
| | | $\overline{RAS}$ Addr. | $\overline{CAS}$ Addr. | $\overline{RAS}$ Addr. | $\overline{CAS}$ Addr. | $\overline{RAS}$ Addr. | $\overline{CAS}$ Addr. |
| 256K x 64/72/80 | 256K x 16 | 9 | 9 | | | | |
| 512K x 64/72/80 | 256K x 16 | 9 | 9 | | | | |
| 512K x 64/72/80 | 512K x 8 | 10 | 9 | | | | |
| 1M x 64/72/80 | 512K x 8 | 10 | 9 | | | | |
| 1M x 64/72/80 | 1M x 4/16 | 10 | 10 | 12 | 8 | | |
| 2M x 64/72/80 | 1M x 4/16 | 10 | 10 | 12 | 8 | | |
| 2M x 64/72/80 | 2M x 8 | 11 | 10 | 12 | 9 | | |
| 4M x 64/72/80 | 2M x 8 | 11 | 10 | 12 | 9 | | |
| 4M x 64/72/80 | 4M x 4/16 | 11 | 11 | 12 | 10 | *13 | 9 |
| 8M x 64/72/80 | 4M x 4/16 | 11 | 11 | 12 | 10 | *13 | 9 |
| 8M x 64/72/80 | 8M x 8 | 12 | 11 | 13 | 10 | | |
| 16M x 64/72/80 | 8M x 8 | 12 | 11 | 13 | 10 | | |
| 16M x 64/72/80 | 16M x 4/16 | 12 | 12 | 13 | 11 | *14 | 10 |
| 32M x 64/72/80 | 16M x 4/16 | 12 | 12 | 13 | 11 | *14 | 10 |
| 32M x 64/72/80 | 32M x 8 | TBD | TBD | | | | |
| 64M x 64/72/80 | 32M x 8 | TBD | TBD | | | | |
| 64M x 64/72/80 | 64M x 4 | TBD | TBD | | | | |

(Note: All options possible with DRAM standards are shown)
* This addressing option applies to x16 DRAM configuration

b. Allowable configurations: (Byte 11)
- x64 (Non-parity, Byte controls)
- x72 (Parity, Byte controls)
- x72 (ECC-optimized, Byte controls)
- x80 (ECC-optimized, Byte controls)

c. Functional Attributes:
- Power Supply Voltage/Interface levels (Byte 8)
- $\overline{RAS}$ access (Byte 9)
- $\overline{CAS}$ access (Byte 10)
- Refresh rate/type (Byte 12)

**Figure 4.5.3–F**
**168 Pin UNBUFFERED DRAM DIMM SPD ASSIGNMENTS**

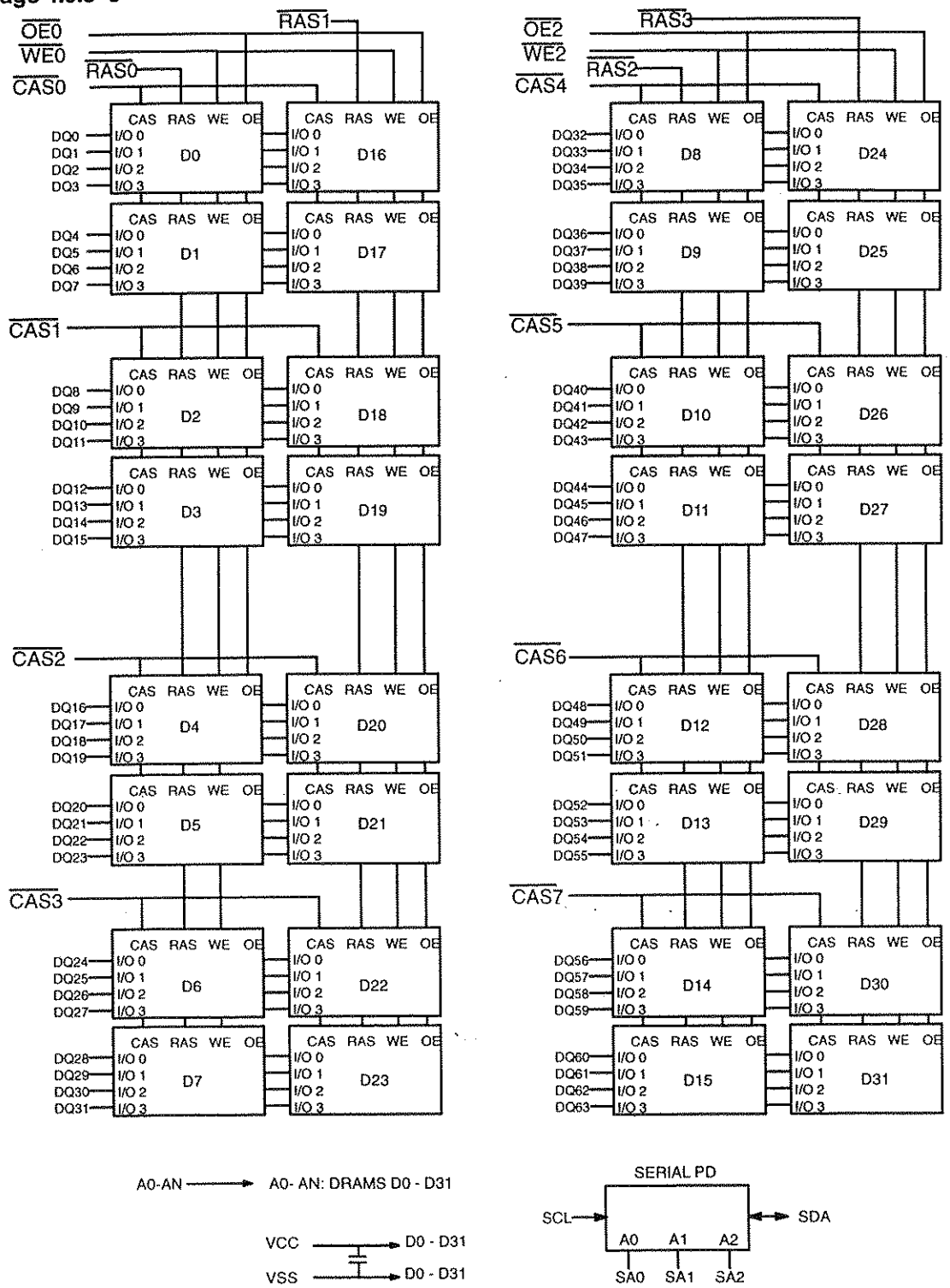



**Figure 4.5.3–G**
**X64 DRAM DIMM, 2 Banks with X4 DRAMs**



XILINX EXHIBIT 1012
Page 366

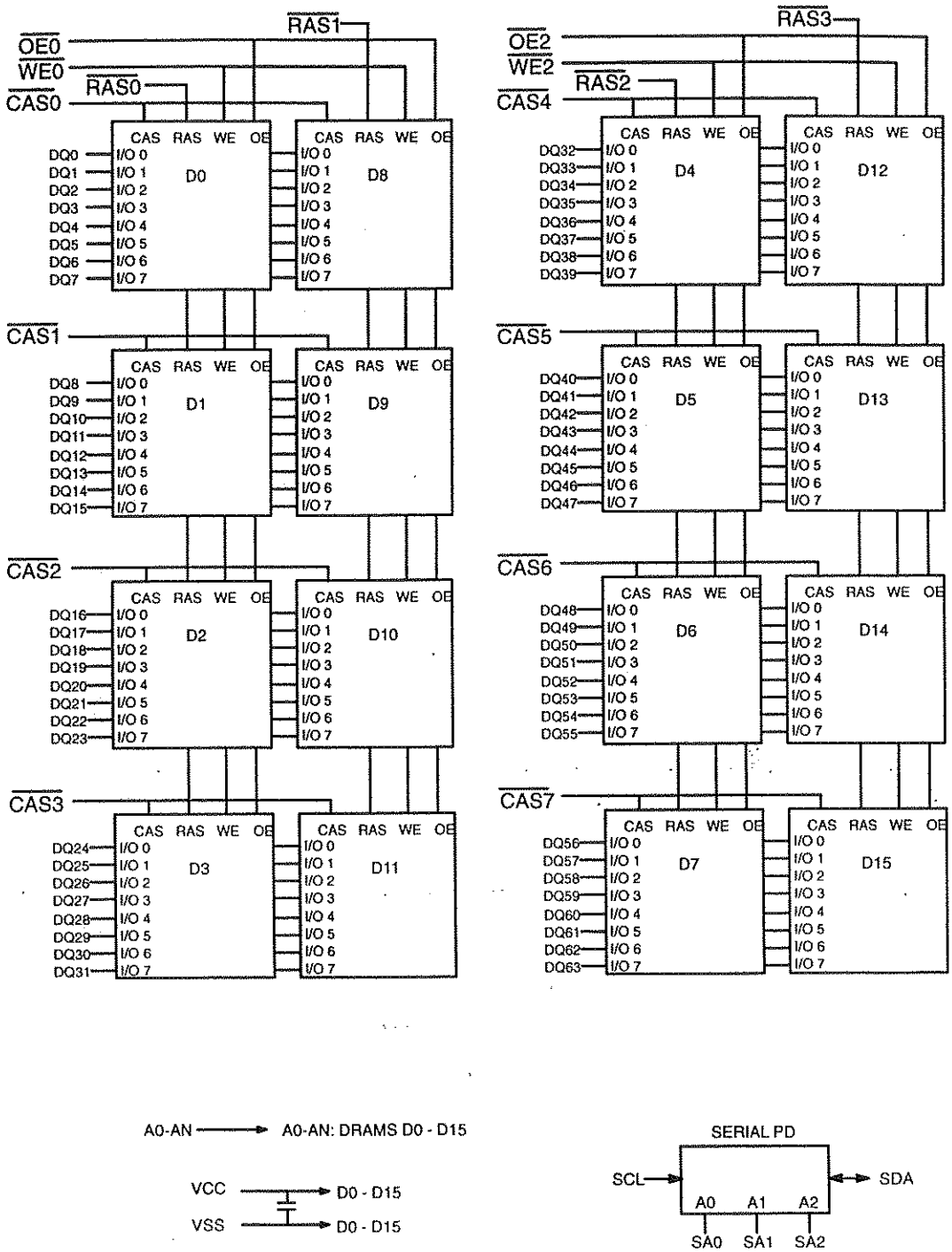



**Figure 4.5.3–H**
**X64 DRAM DIMM, 2 Banks with X8 DRAMs**

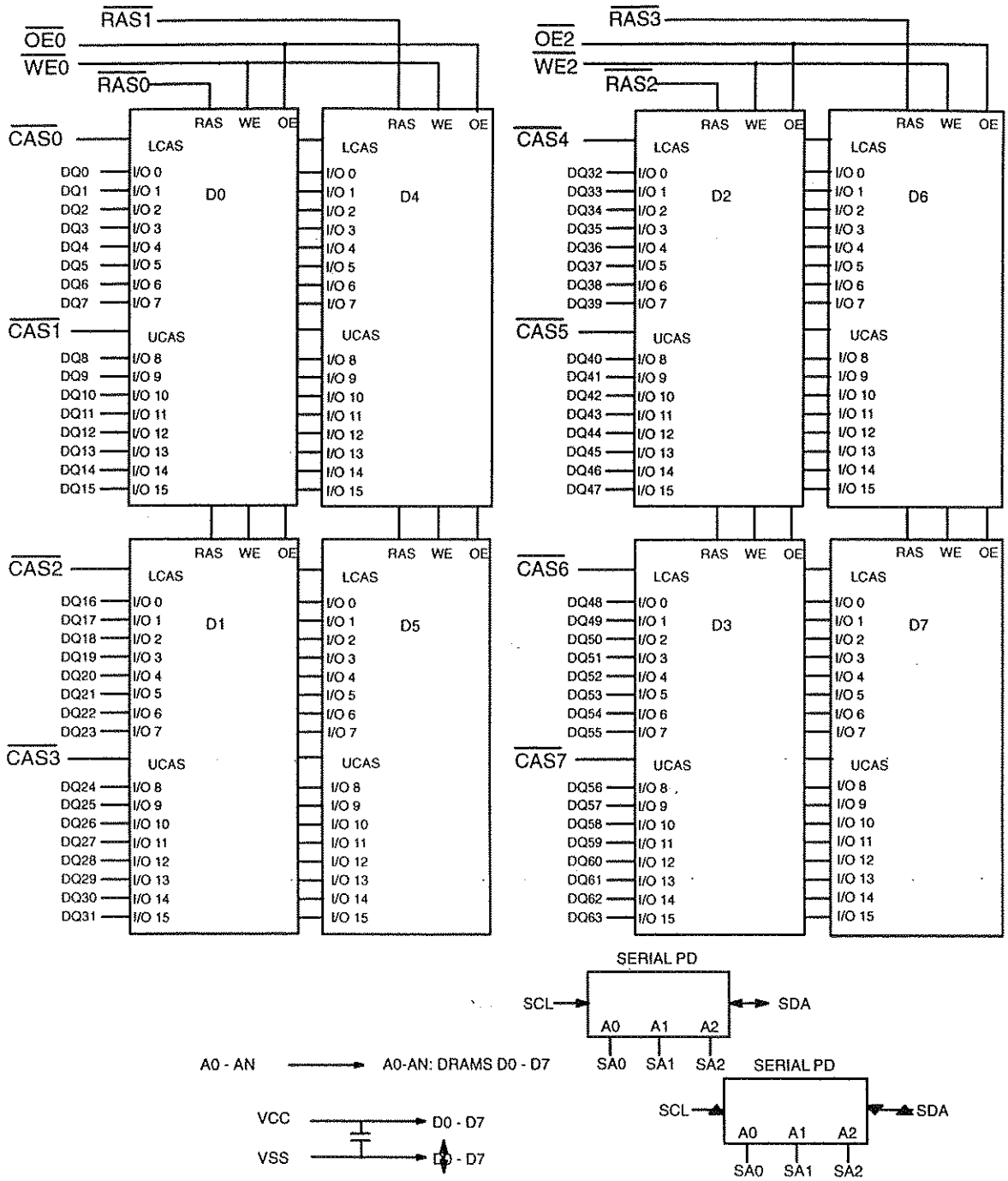



**Figure 4.5.3–I**
**X64 DRAM DIMM, 2 Banks with X16 DRAMs**

Release 7

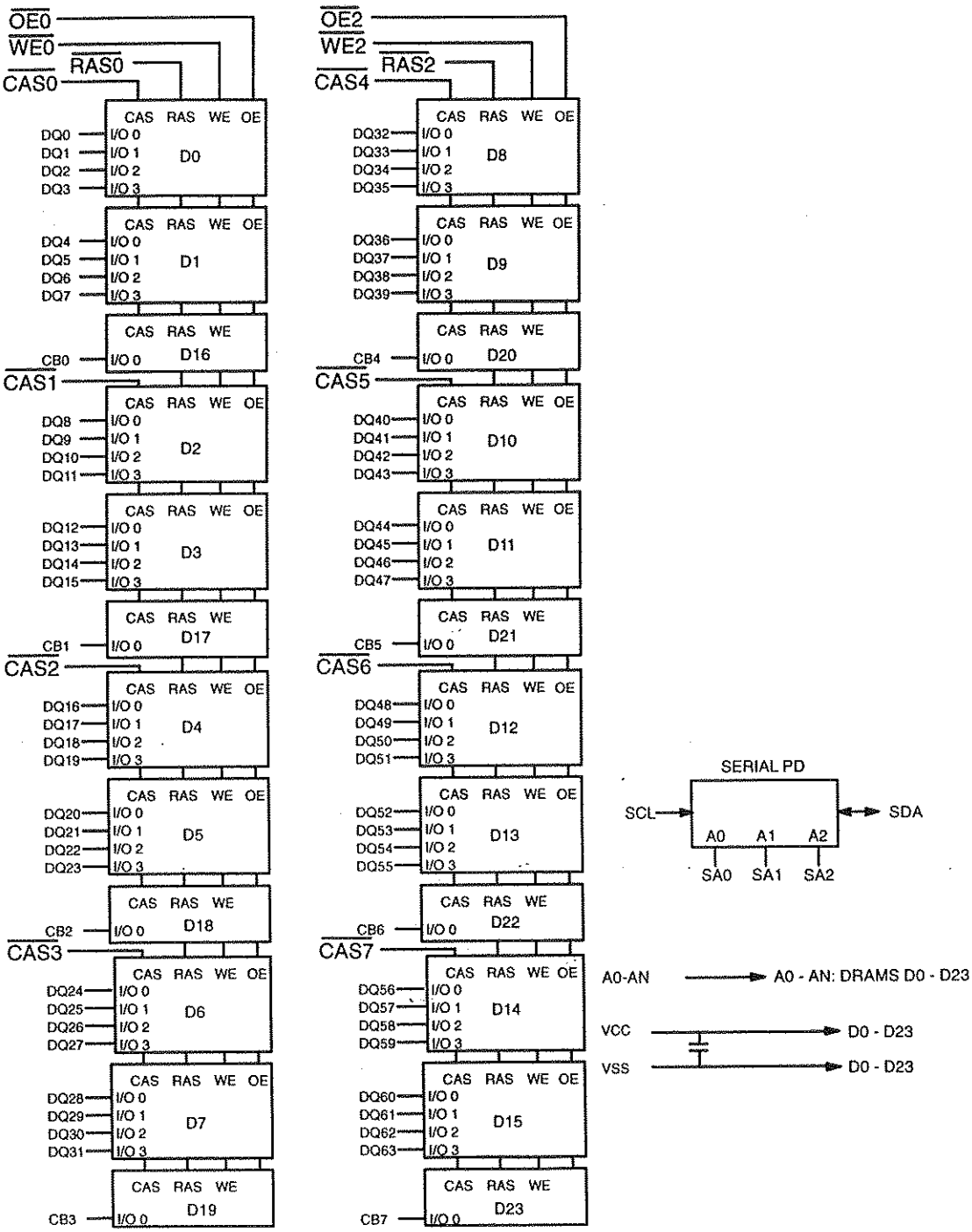



**Figure 4.5.3–J**
**X64 DRAM DIMM, 2 Banks with X4/X1 DRAMs**

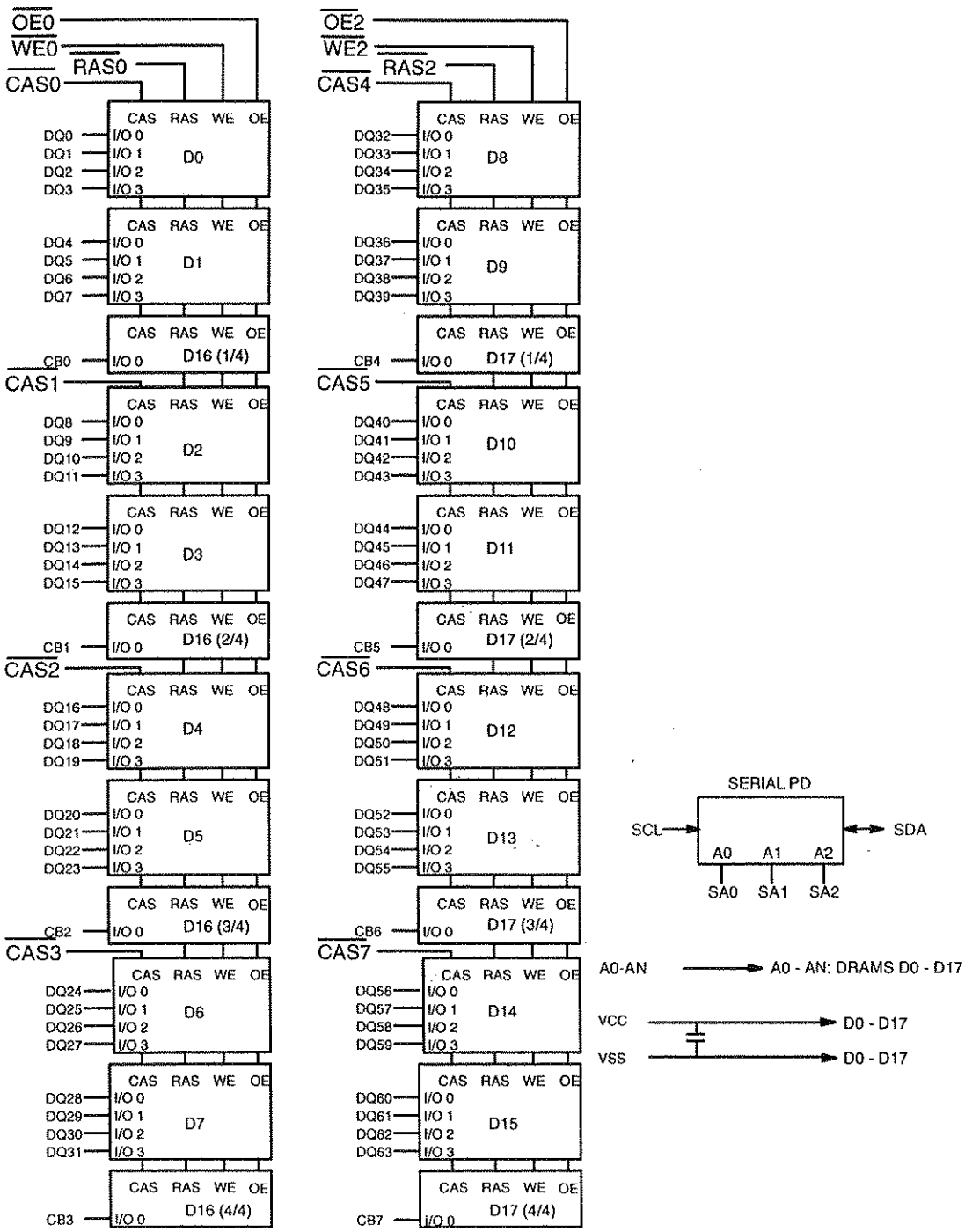
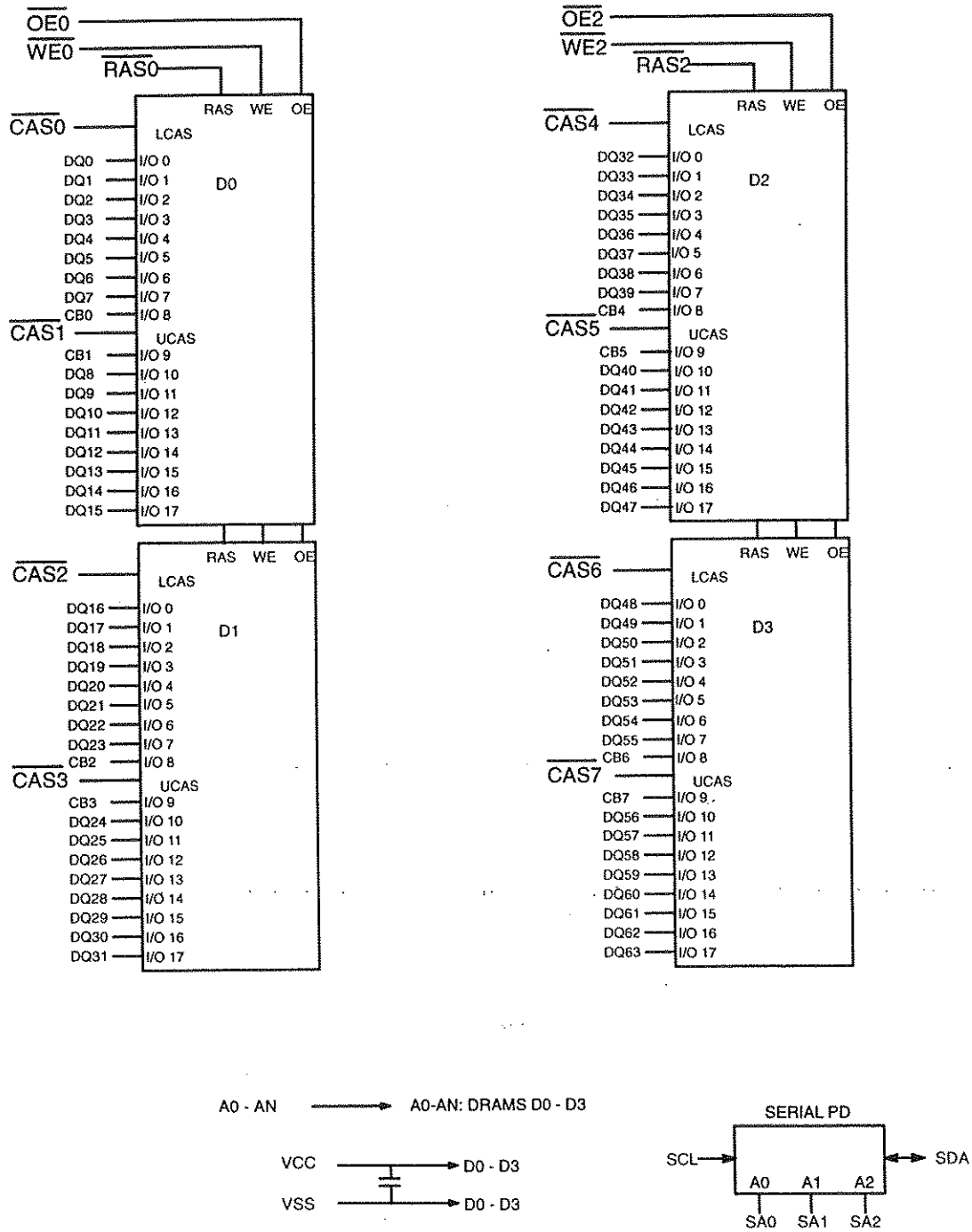



**Figure 4.5.3–K**
**X72 Parity DRAM DIMM, 2 Banks with X4 & X4 W/4 CAS DRAMs**




## Figure 4.5.3–L
## X72 Parity DRAM DIMM, 2 Banks with X16 DRAMs

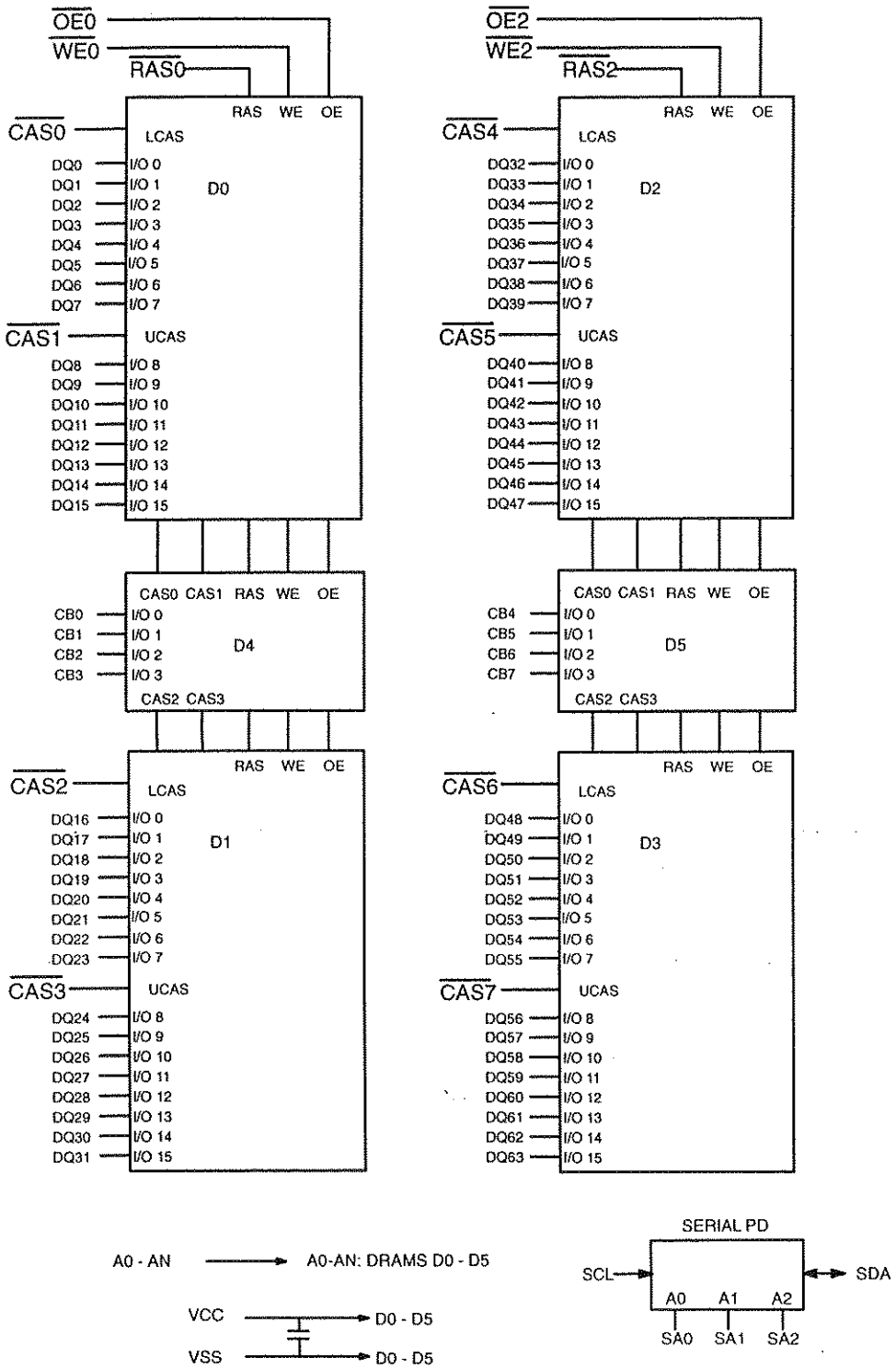



**Figure 4.5.3–M**
**X72 Parity DRAM DIMM, 2 Banks with X16 & X4 W/4 CAS DRAMs**

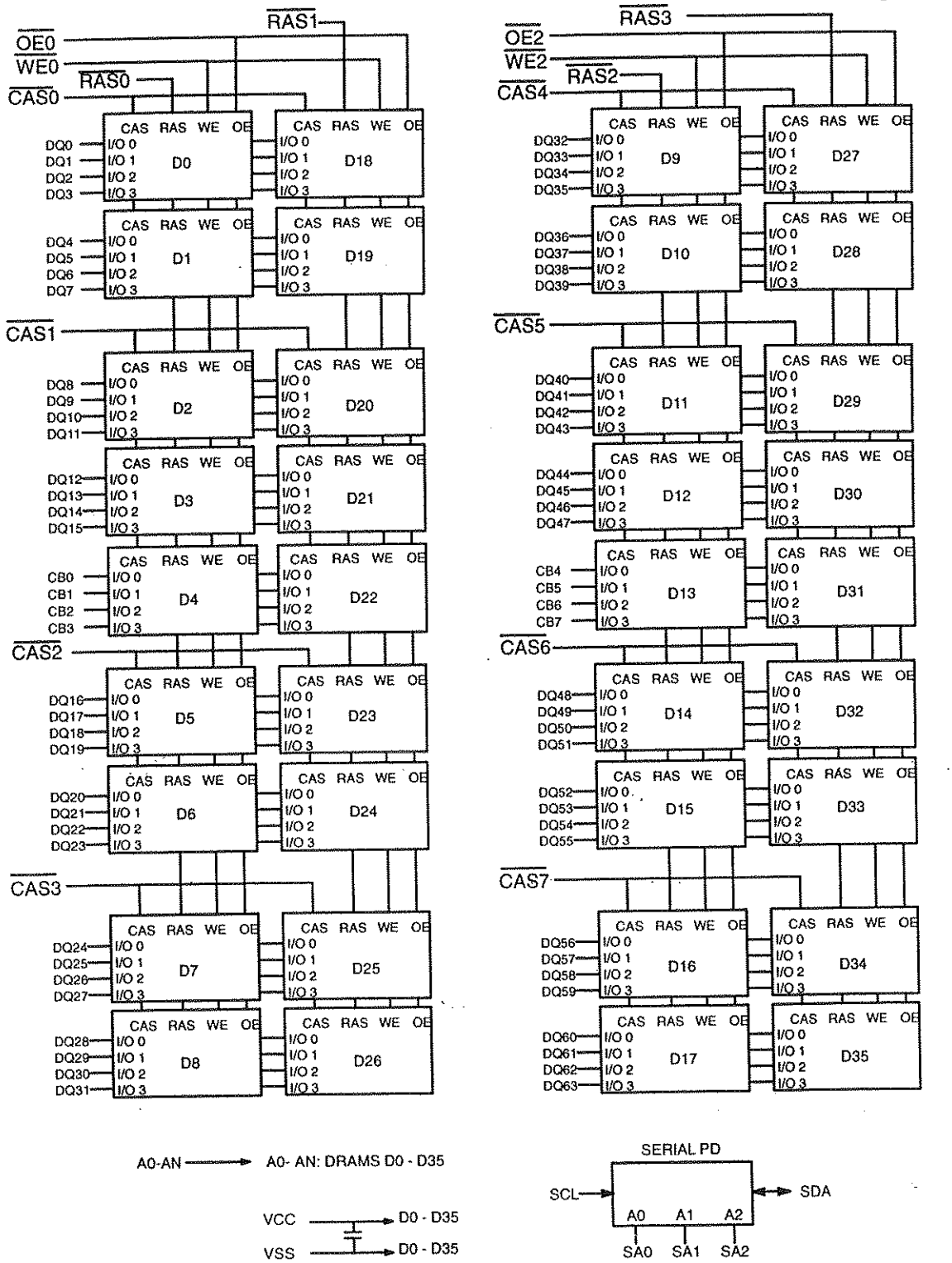



**Figure 4.5.3–N**
**X72 ECC DRAM DIMM, 2 Banks with X4 DRAMs**

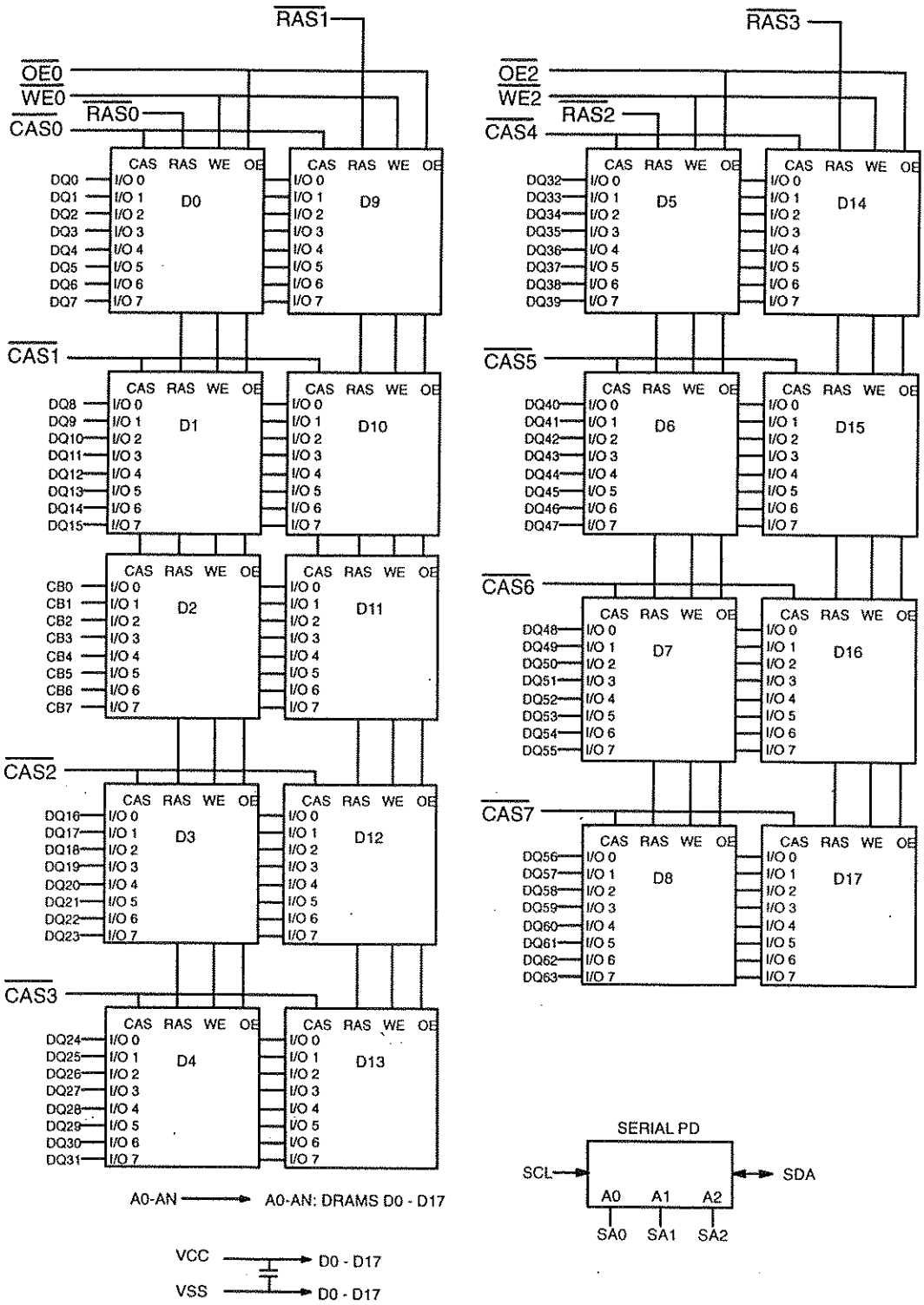



**Figure 4.5.3–O**
**X72 ECC DRAM DIMM, 2 Banks with X8 DRAMs**



XILINX EXHIBIT 1012
Page 374

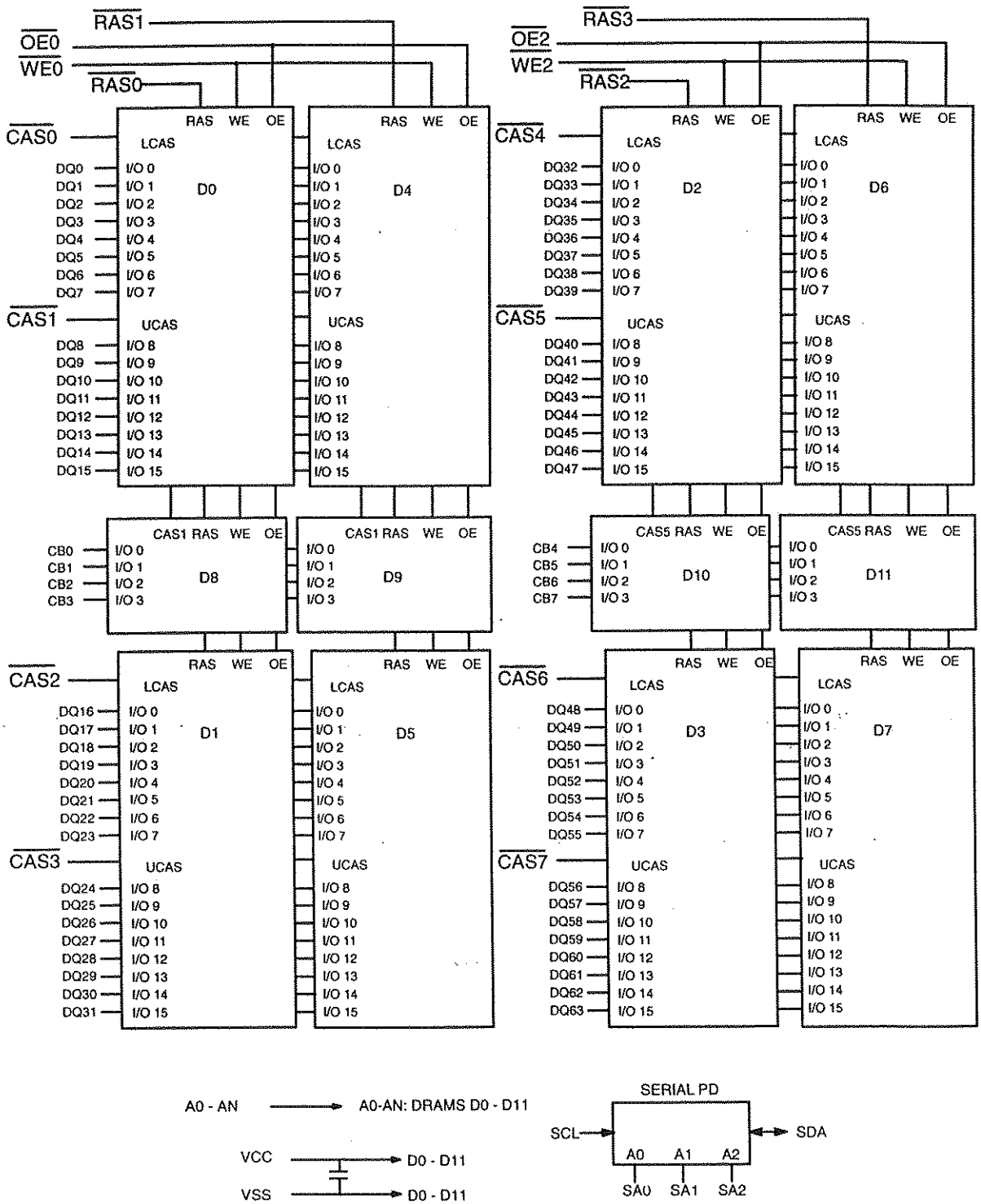



**Figure 4.5.3–P**
**X72 ECC DRAM DIMM, 2 Banks with X16 & X4 DRAMs**

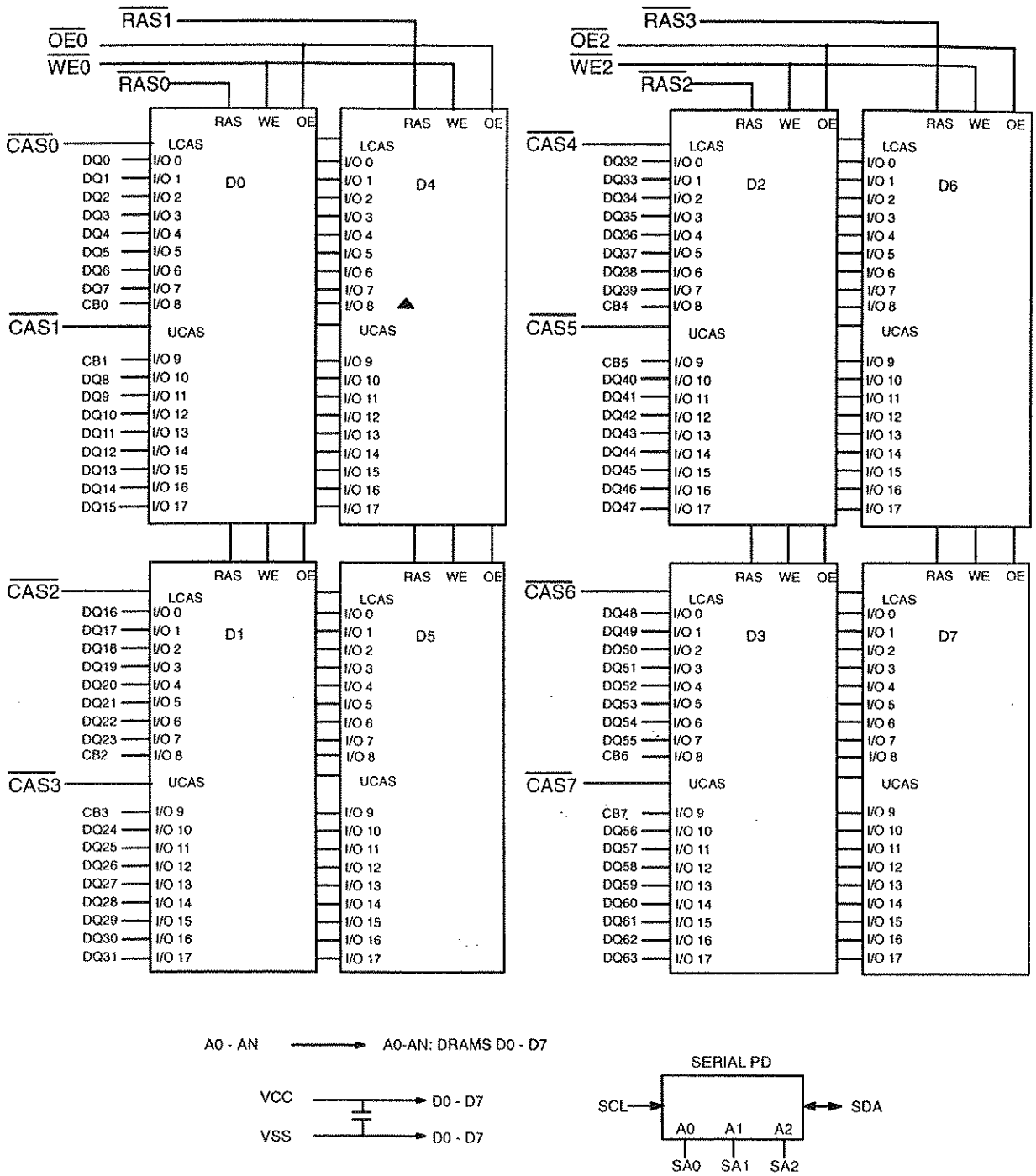



**Figure 4.5.3–Q**
**X72 ECC DRAM DIMM, 2 Banks with X18 DRAMs**



XILINX EXHIBIT 1012
Page 376

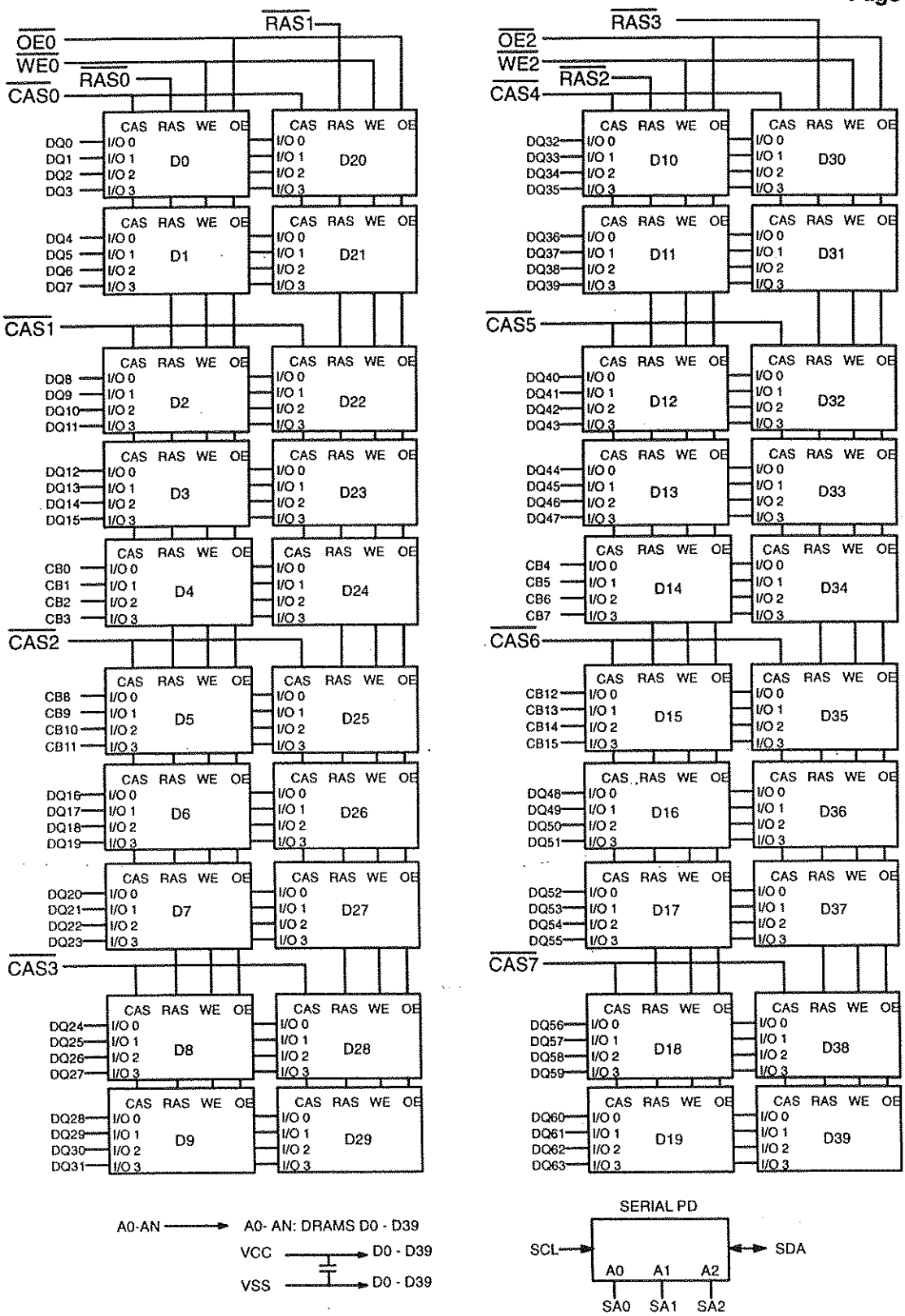



**Figure 4.5.3–R**
**X80 DRAM DIMM, 2 Banks with X4 DRAMs**

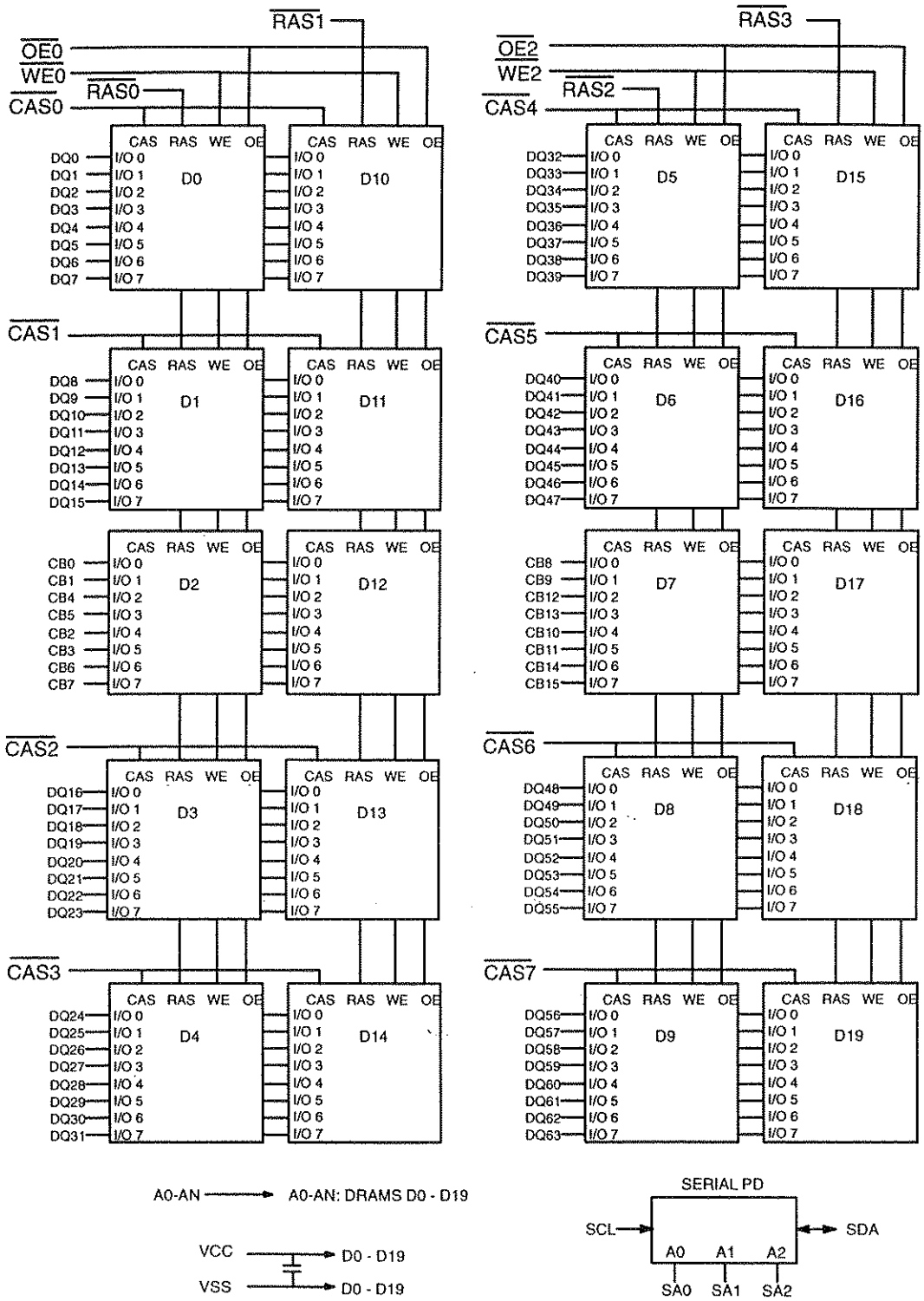



**Figure 4.5.3–S**
**X80 ECC DRAM DIMM, 2 Banks with X8 DRAMs**

## 4.5.4 – 168 PIN UNBUFFERED SDRAM DIMM FAMILY

CAPACITY—256K, 512K, 1M, 2M, 4M, 8M, 16M, 32M, & 64M WORDS OF 64, 72, OR 80 BITS
DATA CONFIGURATIONS—Four DATA Word configurations are defined:
—64 BIT without PARITY
—72 BIT for PARITY CODES
—72 BIT & 80 BIT for ECC CODES
CONFIGURATION—21 Different Configurations are defined using various combinationa of X1, X4, X8, X9, X16 and X18 memories including 2 bank configurations using X4 devices.
LOGIC FEATURES—The modules contain "PRESENCE DETECT" and "IDENTITY" featurs that conist of output pins in the PDn and IDn fields which supply encoded values that define the storage capacity, configuration, data word configuration, refresh mode, and speed of the module.
PACKAGE—168 PIN JEDEC DIMM MEMORY MODULE
PIN ASSIGNMENTS—Figs. 4.5.4–A, & 4.5.4–B,
SPD TABLE & INFORMATION—Fig. 4.5.4–C
Comparison of 168 Pin Buffered & Unbuffered DRAM & SDRAM DIMM—Fig. 4.5.4–D
KEYING METHODOLOGY—Fig. 4.5.4–E
PINOUT COMPARISON DRAM & SDRAM DIMM—Fig. 4.5.4–F
SDRAM CLOCK LOADING—Fig. 4.5.4–G
SDRAM CLOCK WIRING—Fig. 4.5.4–H
CONFIGURATION BLOCK DIAGRAM—Figs. 4.5.4–I through 4.5.4–Y



XILINX EXHIBIT 1012
Page 379

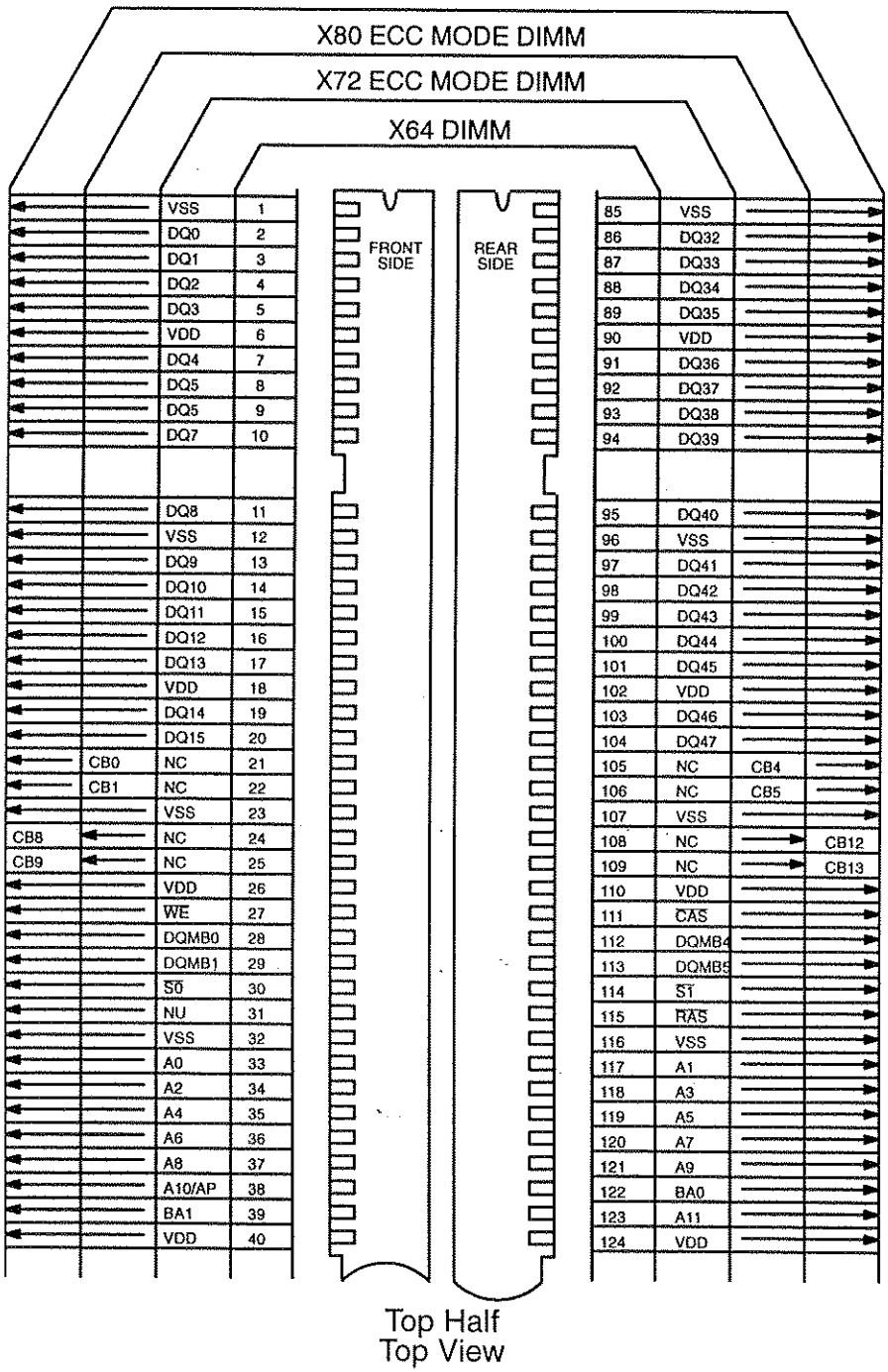



**FIGURE 4.5.4–A**
**168 PIN, 64, 72, or 80 BIT SDRAM DIMM PINOUT, TOP HALF**

Release 7

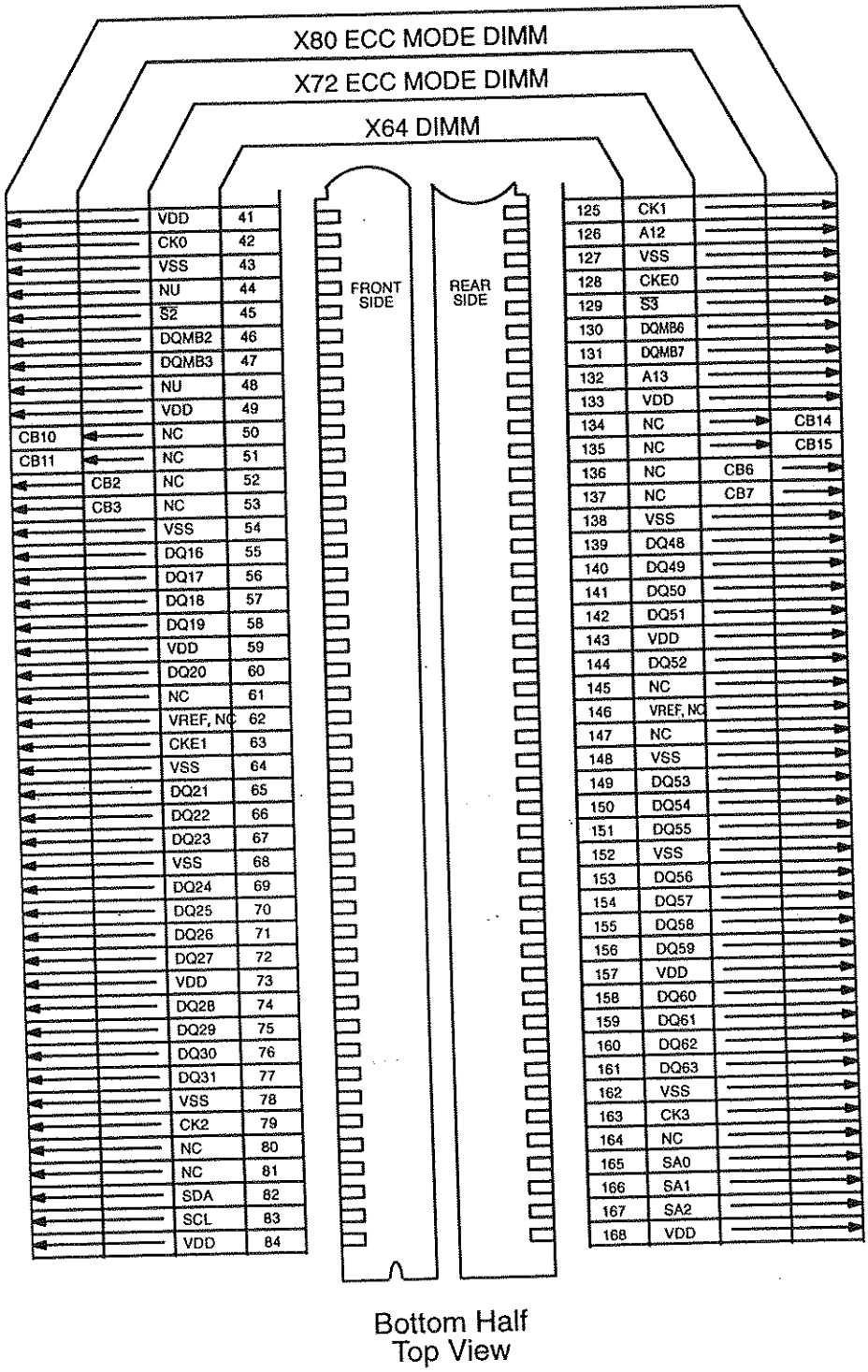



**FIGURE 4.5.4–B**
**168 PIN, 64, 72, or 80 BIT SDRAM DIMM PINOUT, BOTTOM HALF**

| Module Configuration | SDRAM Organization | Option 1 | | | Option 2 | | | Option 3 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | # Bank accr. | $\overline{RAS}$ accr. | $\overline{CAS}$ accr. | # Bank accr. | $\overline{RAS}$ accr. | $\overline{CAS}$ accr. | # Bank accr. | $\overline{RAS}$ accr. | $\overline{CAS}$ accr. |
| 1M x 64/72/80 | 1M x 16 | 1 | 11 | 8 | | | | | | |
| 2M x 64/72/80 | 1M x 16 | 1 | 11 | 8 | | | | | | |
| 2M x 64 | 2M x 32 | 2 | 11 | 8 | | | | | | |
| 2M x 64/72/80 | 2M x 8 | 1 | 11 | 9 | | | | | | |
| 4M x 64/72/80 | 2M x 8 | 1 | 11 | 9 | | | | | | |
| 4M x 64 | 2M x 32 | 2 | 11 | 8 | | | | | | |
| 4M x 64/72/80 | 4M x 4 | 1 | 11 | 10 | | | | | | |
| 4M x 64/72/80 | 4M x 16 | 2 | 12 | 8 | 1 | 13 | 8 | | | |
| 8M x 64/72/80 | 4M x 16 | 2 | 12 | 8 | 1 | 13 | 8 | | | |
| 8M x 64 | 8M x 32 | 2 | 13 | 8 | 2 | 12 | 9 | | | |
| 8M x 64/72/80 | 8M x 8 | 2 | 12 | 9 | 1 | 13 | 9 | | | |
| 16M x 64/72/80 | 8M x 8 | 2 | 12 | 9 | 1 | 13 | 9 | | | |
| 16M x 64 | 8M x 32 | 2 | 13 | 8 | 2 | 12 | 9 | | | |
| 16M x 64/72/80 | 16M x 4 | 2 | 12 | 10 | 1 | 13 | 10 | | | |
| 16M x 64/72/80 | 16M x 16 | 2 | 13 | 9 | | | | | | |
| 32M x 64/72/80 | 16M x 16 | 2 | 13 | 9 | | | | | | |
| 32M x 64/72/80 | 32M x 8 | 2 | 13 | 10 | | | | | | |
| 64M x 64/72/80 | 32M x 8 | 2 | 13 | 10 | | | | | | |
| 64M x 64/72/80 | 64M x 4 | 2 | 13 | 11 | | | | | | |
| (Note: All options possible with SDRAM standards are shown) | | | | | | | | | | |

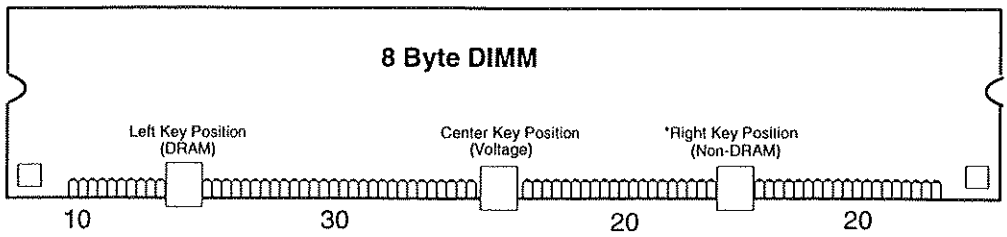
b. Allowable configurations: (Byte 11)
   - x64 (Non-parity, Byte controls)
   - x72 (ECC-optimized, Byte controls)
   - x80 (ECC-optimized, Byte controls)

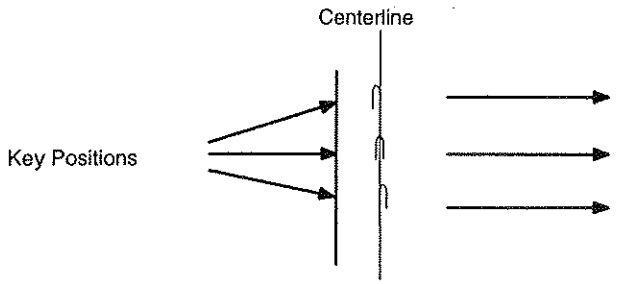
c. Functional Attributes:
   - Power Supply Voltage/Interface levels (Byte 8)
   - SDRAM cycle time (Byte 9)
   - SDRAM access from Clock (Byte 10)
   - Refresh rate/type (Byte 12)
   - SDRAM module attributes (Byte 13)
   - SDRAM device attributes (Bytes 14 - 20)
   - Primary/Secondary DRAM (Bytes 21 - 22)

## Figure 4.5.4–C
## 168 Pin UNBUFFERED DRAM DIMM SPD ASSIGNMENTS

| Buffered | Unbufffered |
|---|---|
| All signals except RAS and Data are buffered | No buffers, all DRAM signals are connected directly to DIMM tab pins |
| 11 Pins are used for DIMM attributes (PDE, PD1-8, ID0-1) | 5 pins are used for DIMM attributes (SDA, SCL, SA0-2) |
| CAS Pin assignment sequence optimized for buffer placement<br>0, 1<br>2, 3<br>4, 5<br>6, 7 | CAS Pin signals are re-assigned for optimal DRAM placement<br>0, 4<br>1, 5<br>2, 6<br>3, 7 |
| ECC DIMMs use subset of CAS signals for word selection (CAS0/1 and CAS4/5) | All DIMM types use byte selection (CAS0-7) |
| Address 0 to the DRAMs is sourced from separate pins (A0, B0) for 4 byte interleave | Single address pin (A0) |
| Data pin assignment uses both X64/X72 and X80 numbering schemes | Data pin assignment is changed to single x80 numbering scheme with x64 and x72 as subsets |
| Non-Parity is subset of Parity with inter-mixed Parity bits unconnected (PQ8, 17, 26, 35, 44, 53, 62, 71) | All DIMM types use the same sequential 64 data pins (DQ0-63).<br><br>Eight center pins (CB0-7) are used as Parity/Check Bits for x72 Parity/ECC DIMMs.<br><br>An additional 8 center pins (CB8-15) are used for the x80 ECC DIMMs. |
| 32 Power/Gnd Pins<br>VCC - 16<br>VSS - 16 | 35 Power/Gnd Pins<br>VCC - 17 (1 additional pin)<br>VSS - 18 (2 additional pins) |
| Unused Pins - 18 | Unused Pins - 14 |
| Left Key Definition<br>SDRAM<br>STD DRAM<br>RFU | Left Key Definition modified<br>RFU<br>Buffered Assembly (DRAM/SDRAM)<br>Unbuffered Assembly (DRAM/SDRAM) |

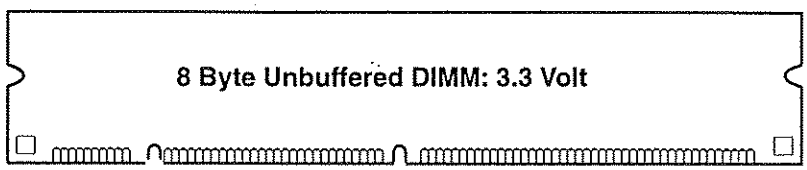
**FIGURE 4.5.4–D**
**Comparison of 168 Pin Buffered & Unbuffered DRAM & SDRAM DIMM**

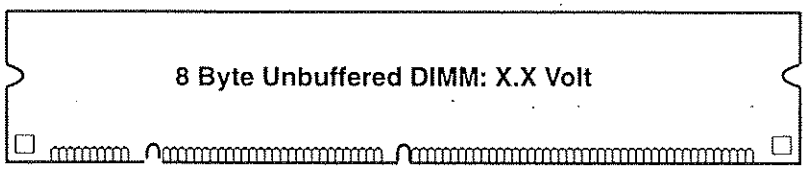



| Left Key | Center Key | *Right Key |
|---|---|---|
| RFU | 5V | No Key |
| BUFFERED ASSEMBLY | 3.3V | No Key |
| UNBUFFERED ASSEMBLY | X.XV | No Key |

* For DRAM/SDRAM assemblies, this area is poplulated with pads.




## FIGURE 4.5.4–E
## 168 Pin DRAM DIMM Keying Methodology

| Pin number | DRAM DIMM | SDRAM DIMM |
|---|---|---|
| 39 | A12 | BA1 |
| | | |
| 42 | DU | CK0 |
| | | |
| 44 | $\overline{OE2}$ | DU |
| 45 | $\overline{RAS2}$ | $\overline{S2}$ |
| 46 | $\overline{CAS2}$ | DQMB2 |
| 47 | $\overline{CAS3}$ | DQMB3 |
| 48 | $\overline{WE2}$ | DU |
| | | |
| 62 | DU | $V_{REF}$, NC |
| 63 | NC | CKE1 |
| | | |
| 79 | NC | CK2 |
| | | |
| 111 | DU | $\overline{CAS}$ |
| 112 | $\overline{CAS4}$ | DQMB4 |
| 113 | $\overline{CAS5}$ | DQMB5 |
| 114 | $\overline{RAS1}$ | $\overline{S1}$ |
| 115 | DU | $\overline{RAS}$ |
| | | |
| 122 | A11 | BA0 |
| 123 | A13 | A11 |
| | | |
| 125 | DU | CK1 |
| 126 | DU | A12 |
| | | |
| 128 | DU | CKE0 |
| 129 | $\overline{RAS3}$ | $\overline{S3}$ |
| 130 | $\overline{CAS6}$ | DQMB6 |
| 131 | $\overline{CAS7}$ | DQMB7 |
| 132 | DU | A13 |
| | | |
| 146 | DU | $V_{REF}$, NC |
| | | |
| 163 | NC | CK3 |

**Notes:**
1. A10 on DRAM DIMM is also AP on SDRAM DIMM

**FIGURE 4.5.4–F**
**Pinout Comparison, 168 Pin DRAM & SDRAM DIMM**

| X 64 (Non–parity) | | | | | | |
|---|---|---|---|---|---|---|
| | | | CLK Loading | | | |
| SDRAM Data Width | # of Banks on DIMM | Total # SDRAMs | CK0 | CK1 | CK2 | CK3 |
| x4 | 1 | 16 | 4 | 4 | 4 | 4 |
| x8 | 1 | 8 | 4 | 4 | * | * |
| x16 | 1 | 4 | 4 | * | * | * |
| x32 | 1 | 2 | *2 | * | * | * |
| x8 | 2 | 16 | 4 | 4 | 4 | 4 |
| x16 | 2 | 8 | 4 | 4 | * | * |
| x32 | 2 | 4 | 4 | * | * | * |

| X 72 (ECC) | | | | | | |
|---|---|---|---|---|---|---|
| | | | CLK Loading | | | |
| SDRAM Data Width | # of Banks on DIMM | Total # SDRAMs | CK0 | CK1 | CK2 | CK3 |
| x4 | 1 | 18 | ** 4 or 5 | ** 4 or 5 | ** 4 or 5 | ** 4 or 5 |
| x8 | 1 | 9 | ** 4 or 5 | ** 4 or 5 | * | * |
| x16/x4 | 1 | 6 | 4 (MAX) | 4 (MAX) | * | * |
| x32/x8 | 1 | 3 | *3 | * | * | * |
| x8 | 2 | 18 | ** 4 or 5 | ** 4 or 5 | ** 4 or 5 | ** 4 or 5 |
| x16/x4 | 2 | 12 | 4 | 4 | 4 | |
| x32/x8 | 2 | 6 | 4 (MAX) | 4 (MAX) | * | * |

| X 80 (ECC) | | | | | | |
|---|---|---|---|---|---|---|
| | | | CLK Loading | | | |
| SDRAM Data Width | # of Banks on DIMM | Total # SDRAMs | CK0 | CK1 | CK2 | CK3 |
| x4 | 1 | 20 | 5 | 5 | 5 | 5 |
| x8 | 1 | 10 | 5 | 5 | * | * |
| x16 | 1 | 5 | 5 | * | * | * |
| x32/x8 | 1 | 4 | 4 | * | * | * |
| x8 | 2 | 20 | 5 | 5 | 5 | 5 |
| x16 | 2 | 10 | 5 | 5 | * | * |
| x32/x8 | 2 | 8 | 4 | 4 | * | * |

**Notes:**

* add padding capacitance per clock wiring detail.

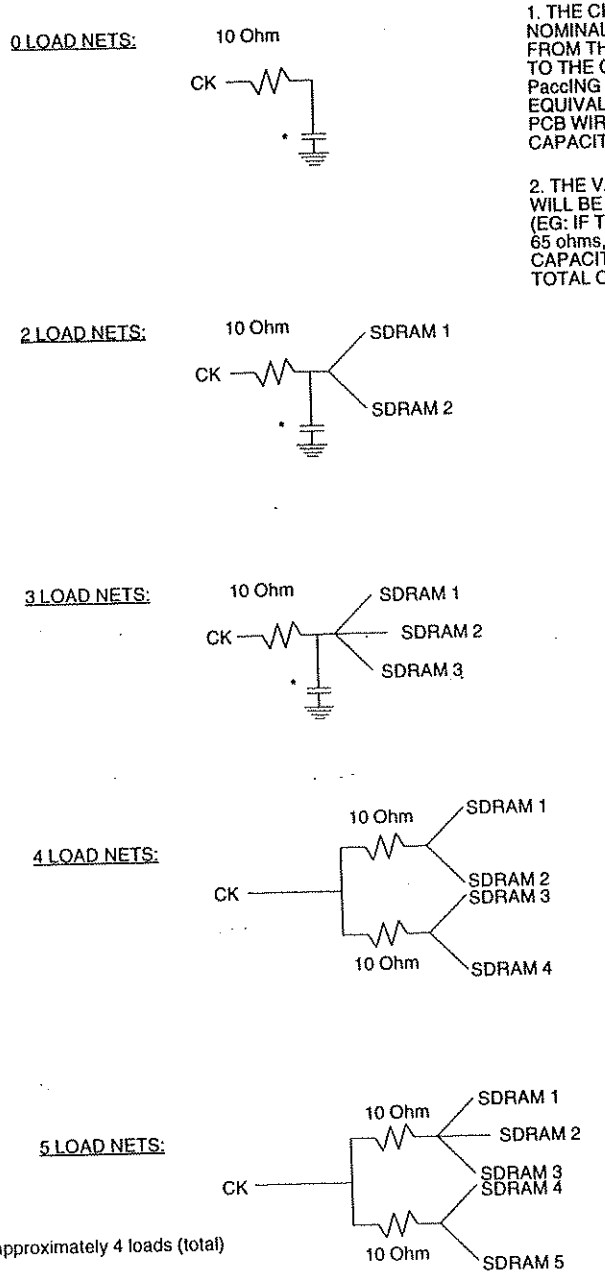
** CK0 + CK2 must total 9 SDRAMs, CK1 + CK3 must total 9 SDRAMs (to allow clock "dotting" at system).

## Figure 4.5.4–G
## 168 Pin UNBUFFERED SDRAM DIMM CLOCK LOADING

TARGET CLOCK (CK) SPECIFICATION:

1. THE CK INPUTS SHOULD HAVE A NOMINAL DELAY OF .6ns MEASURED FROM THE CK INPUT AT THE DIMM TAB TO THE CK INPUT OF THE SDRAM (OR PACCING CAPACITOR). (EG: THIS IS EQUIVALENT TO APPROXIMATELY 3" OF PCB WIRE AND 2.5pf OF INPUT CAPACITANCE).

2. THE VARIATION OF CK INPUT DELAY WILL BE +/- .1ns FOR ALL FOUR CK INPUTS. (EG: IF THE WIRE IMPEDANCE IS APPROX. 65 ohms, THIS CORRESPONDS TO A CAPACITANCE VARIATION OF +/- 3pf IN TOTAL CK INPUT CAPACITANCE).




* add padding capacitance to approximately 4 loads (total)

## Figure 4.5.4–H
## 168 Pin UNBUFFERED DRAM DIMM CLOCK WIRING

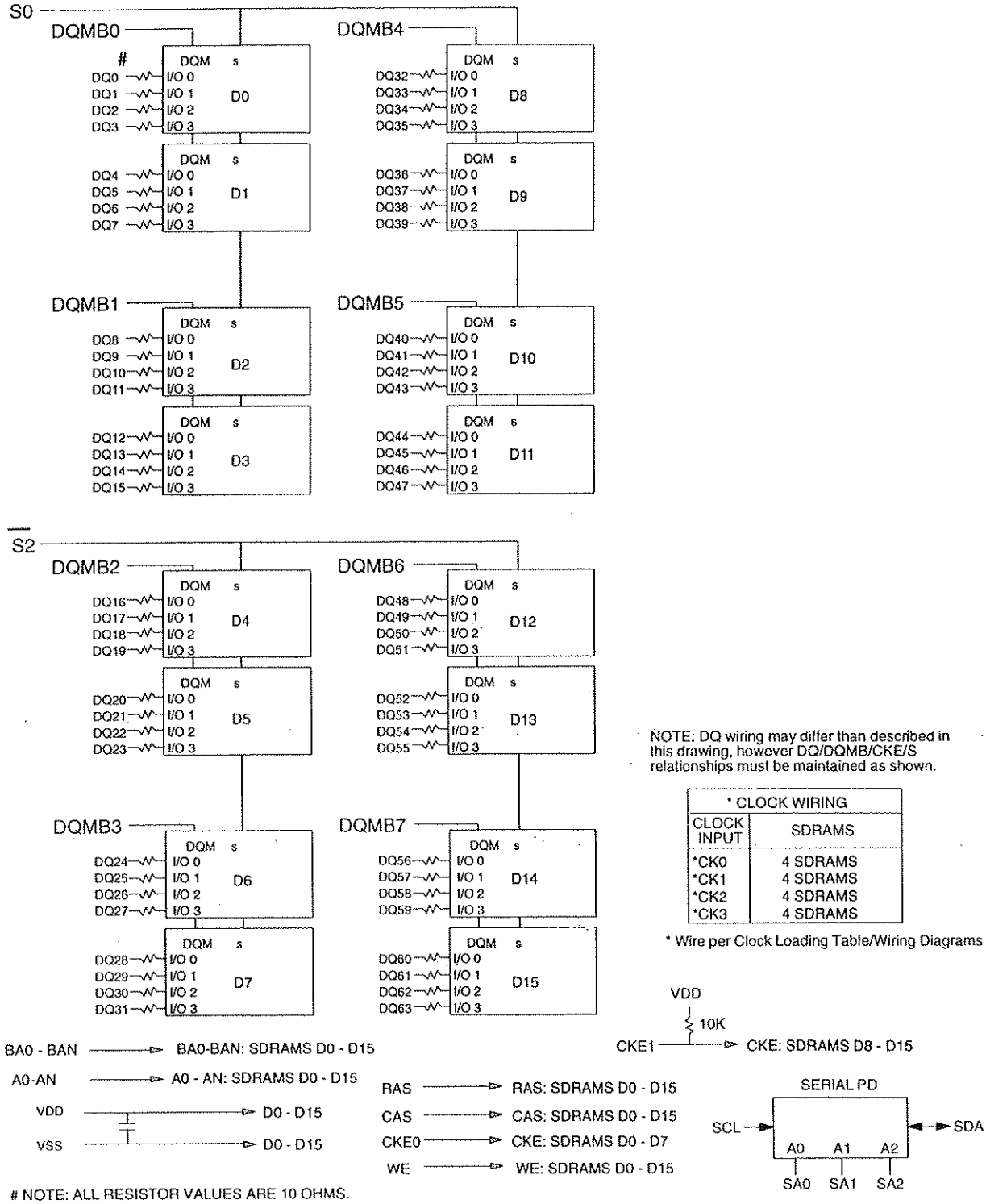



**Figure 4.5.4–I**
**X64 SDRAM DIMM, 1 Bank with X4 SDRAMs**

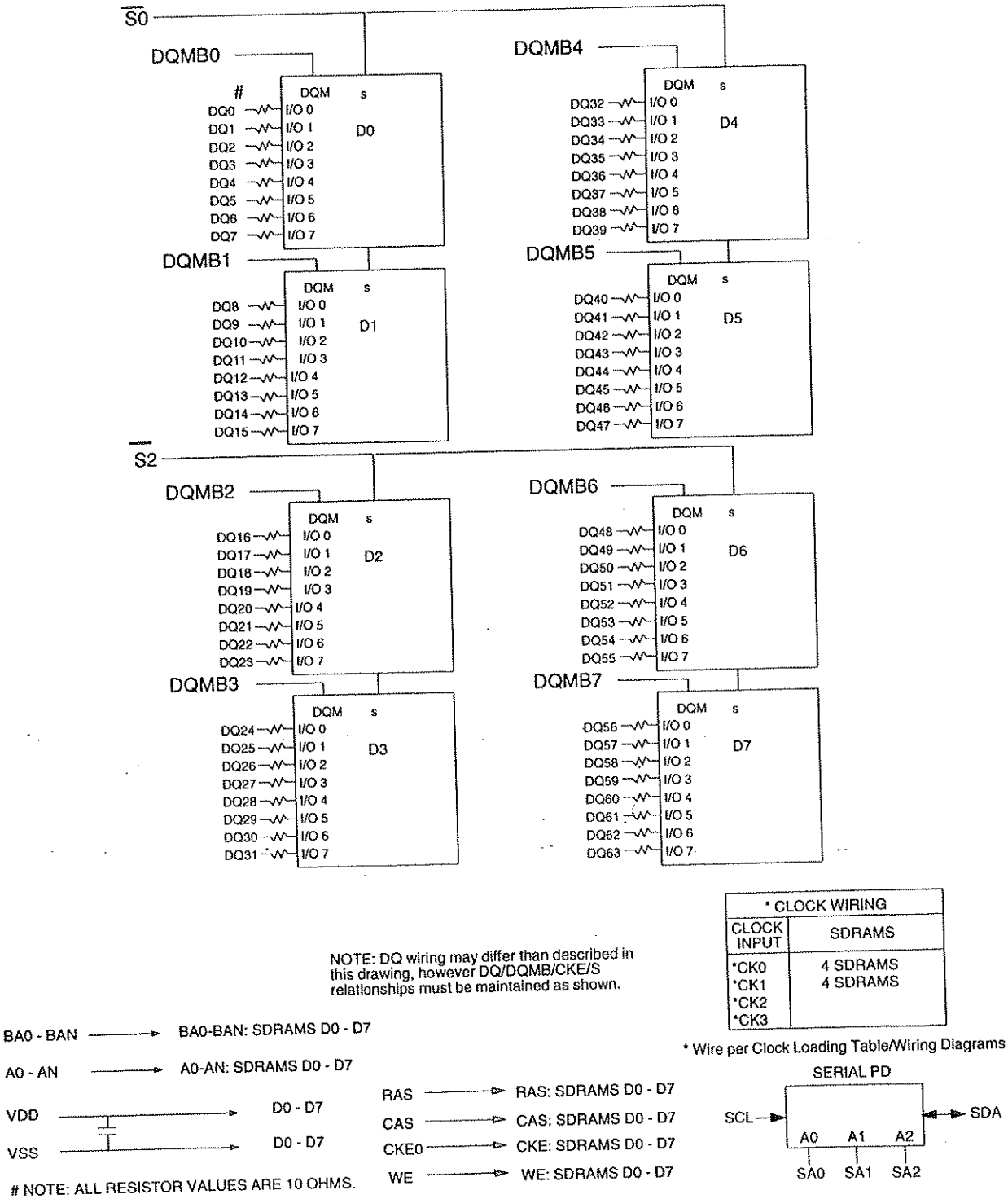
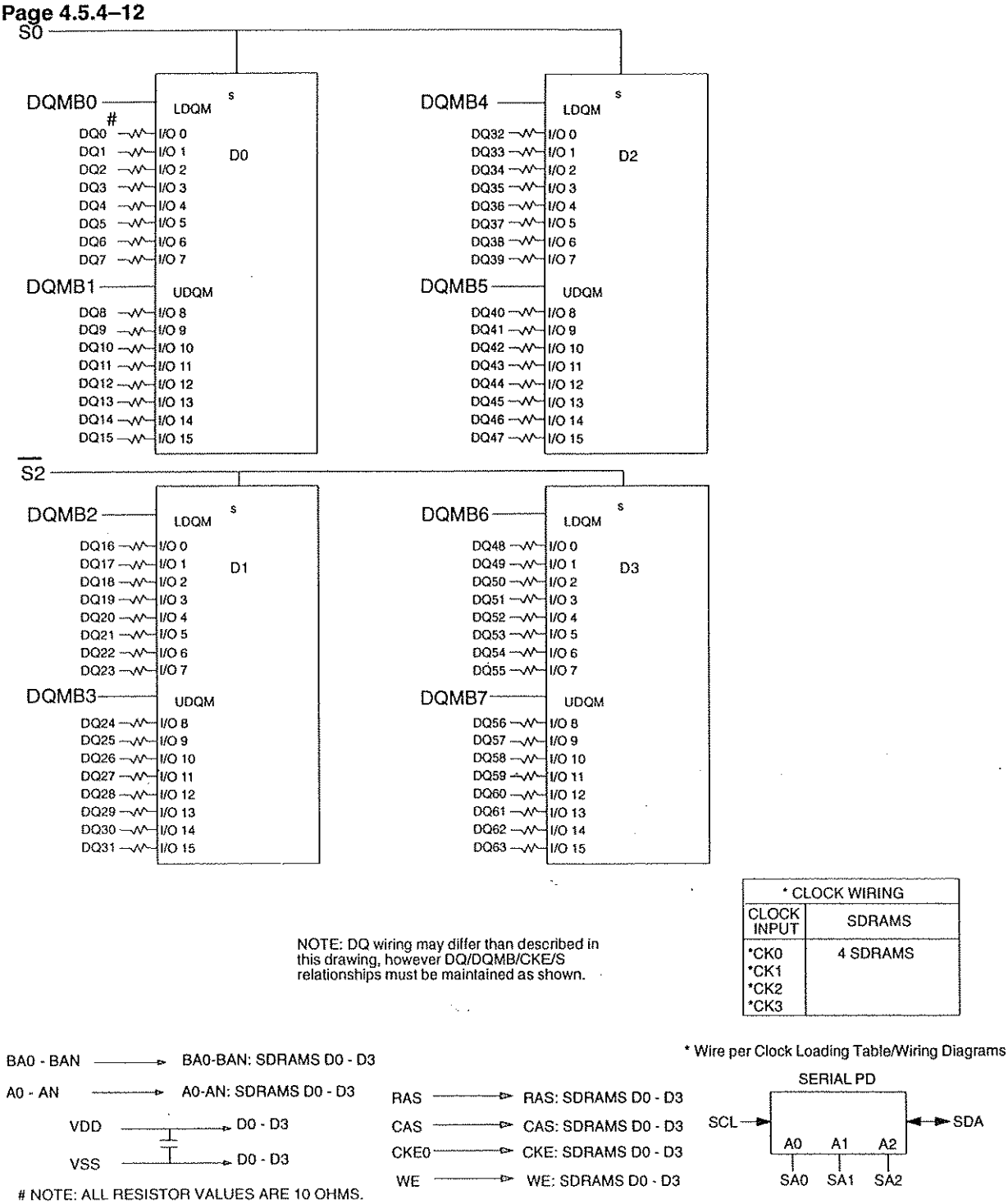
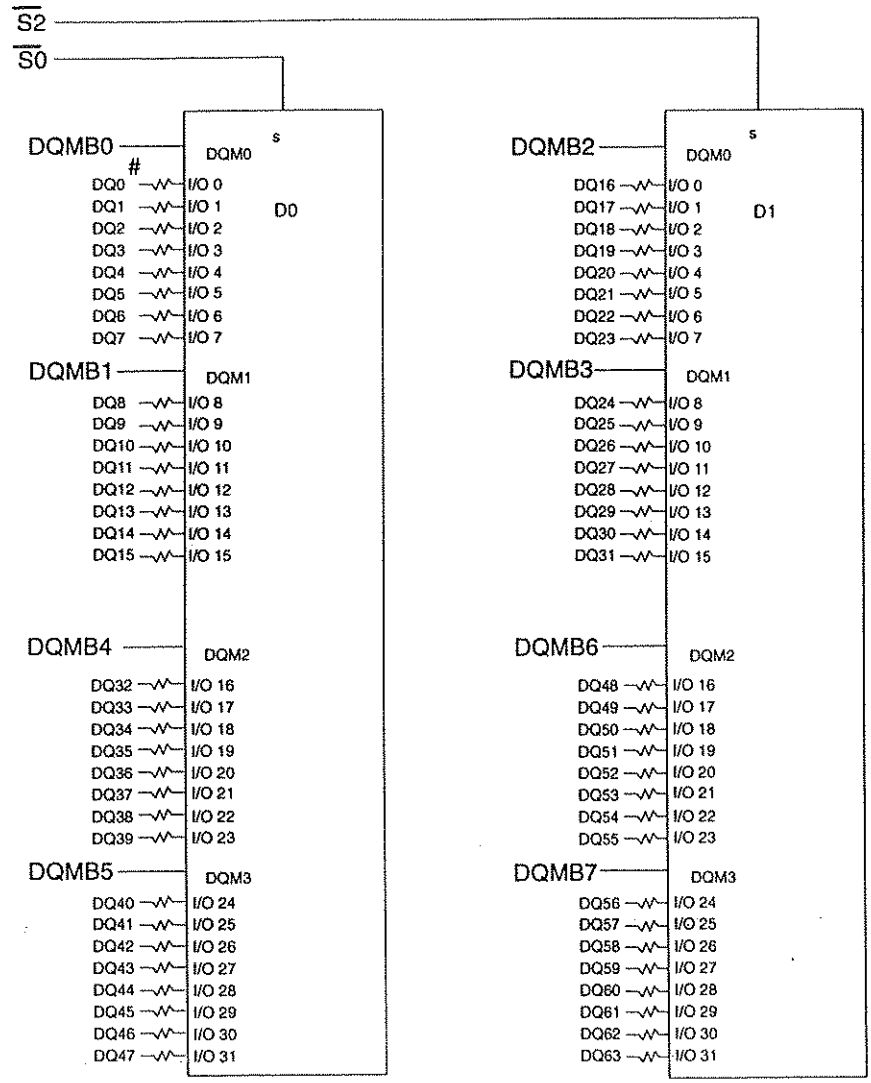



**Figure 4.5.4–J**
**X64 SDRAM DIMM, 1 Bank with X8 SDRAMs**



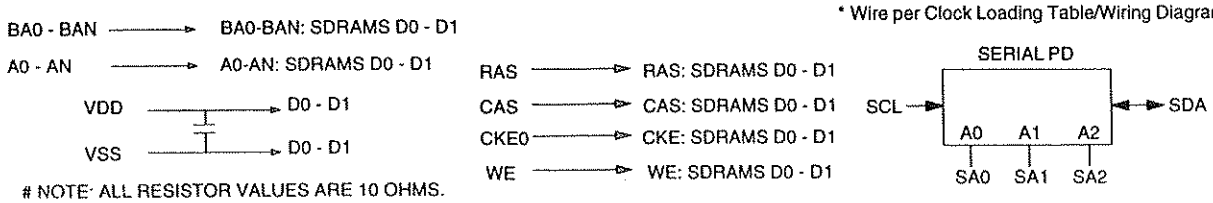

## Figure 4.5.4–K
## X64 SDRAM DIMM, 1 Bank with X16 SDRAMs




NOTE: DQ wiring may differ than described in this drawing, however DQ/DQMB/CKE/S relationships must be maintained as shown.

| * CLOCK WIRING | |
|---|---|
| CLOCK INPUT | SDRAMS |
| *CK0<br>*CK1<br>*CK2<br>*CK3 | 2 SDRAMS |

* Wire per Clock Loading Table/Wiring Diagrams

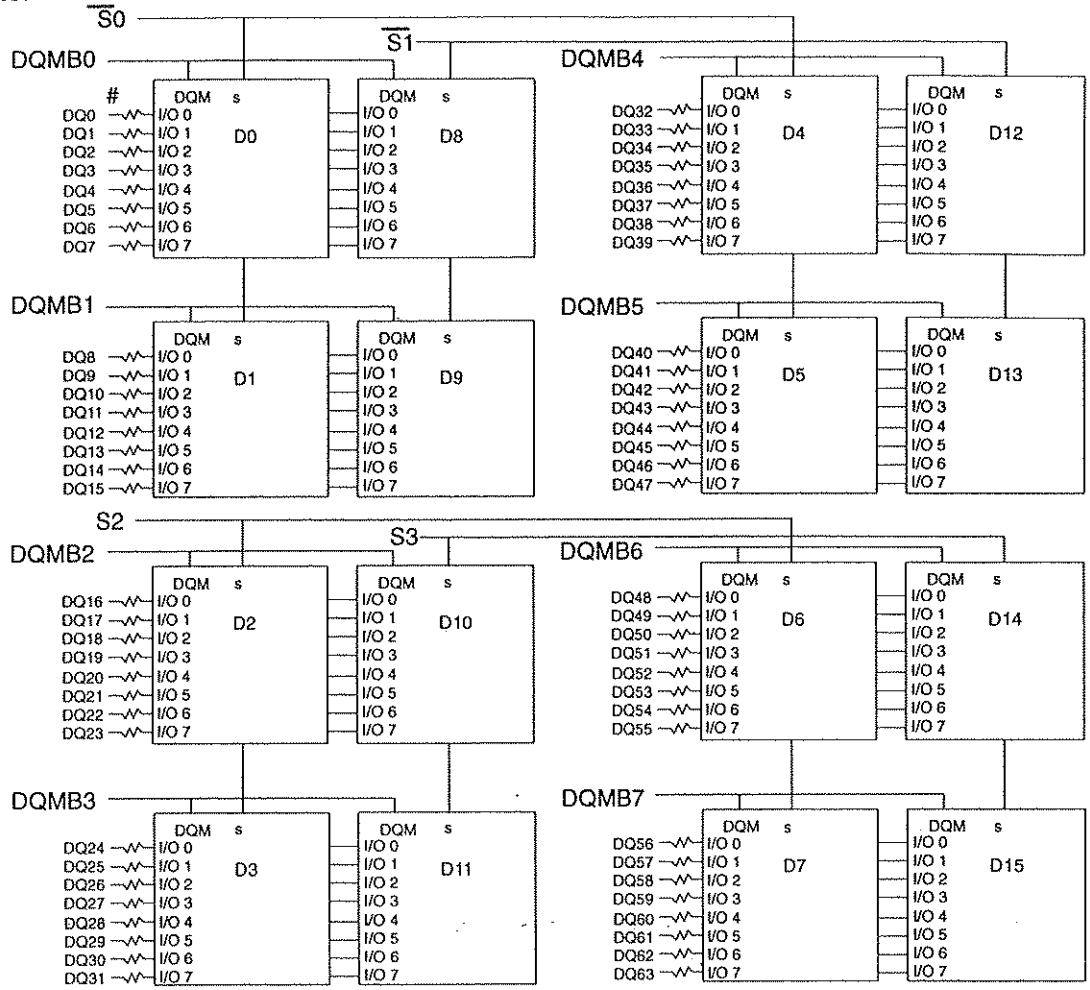



# NOTE: ALL RESISTOR VALUES ARE 10 OHMS.

## Figure 4.5.4–L
## X64 SDRAM DIMM, 1 Bank with X32 SDRAMs



XILINX EXHIBIT 1012
Page 391




| * CLOCK WIRING | |
|---|---|
| CLOCK INPUT | SDRAMS |
| *CK0 | 4 SDRAMS |
| *CK1 | 4 SDRAMS |
| *CK2 | 4 SDRAMS |
| *CK3 | 4 SDRAMS |

* Wire per Clock Loading Table/Wiring Diagrams

NOTE: DQ wiring may differ than described in this drawing, however DQ/DQMB/CKE/S relationships must be maintained as shown.

VDD — 10K — CKE1 → CKE: SDRAMS D8 - D15

BA0 - BAN → BA0-BAN: SDRAMS D0 - D15

A0 - AN → A0-AN: SDRAMS D0 - D15

VDD → D0 - D15

VSS → D0 - D15

# NOTE: ALL RESISTOR VALUES ARE 10 OHMS.

RAS → RAS: SDRAMS D0 - D15

CAS → CAS: SDRAMS D0 - D15

CKE0 → CKE: SDRAMS D0 - D7

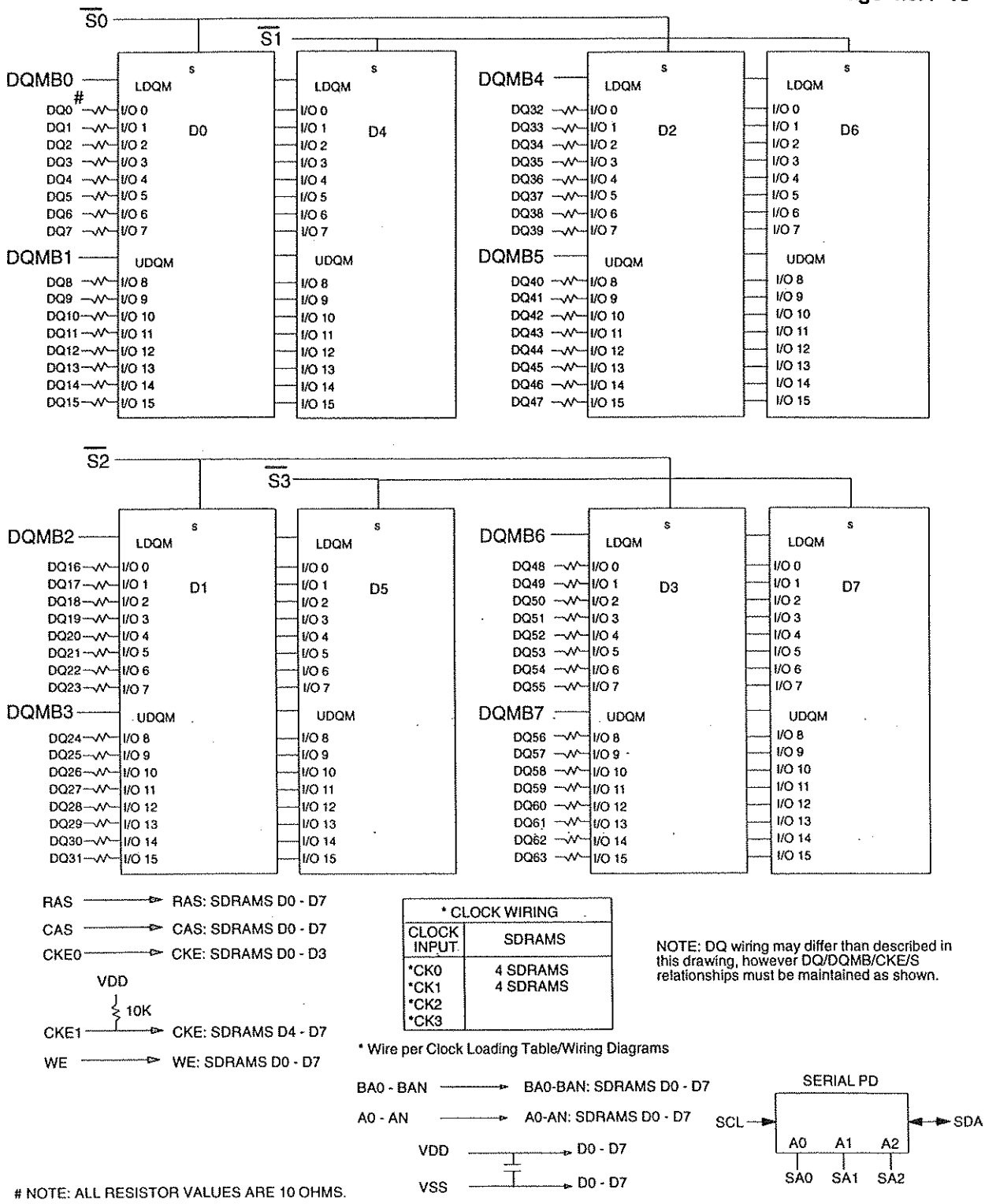
WE → WE: SDRAMS D0 - D15

* Wire per Clock Loading Table/Wiring Diagrams

SERIAL PD: SCL, SDA, A0, A1, A2, SA0, SA1, SA2

VDD — 10K — CKE1 → CKE: SDRAMS D4 - D7, D9, D11

## Figure 4.5.4–M
## X64 SDRAM DIMM, 2 Banks with X8 SDRAMs




## Figure 4.5.4–N
## X64 SDRAM DIMM, 2 Banks with X16 SDRAMs

**Release 7**

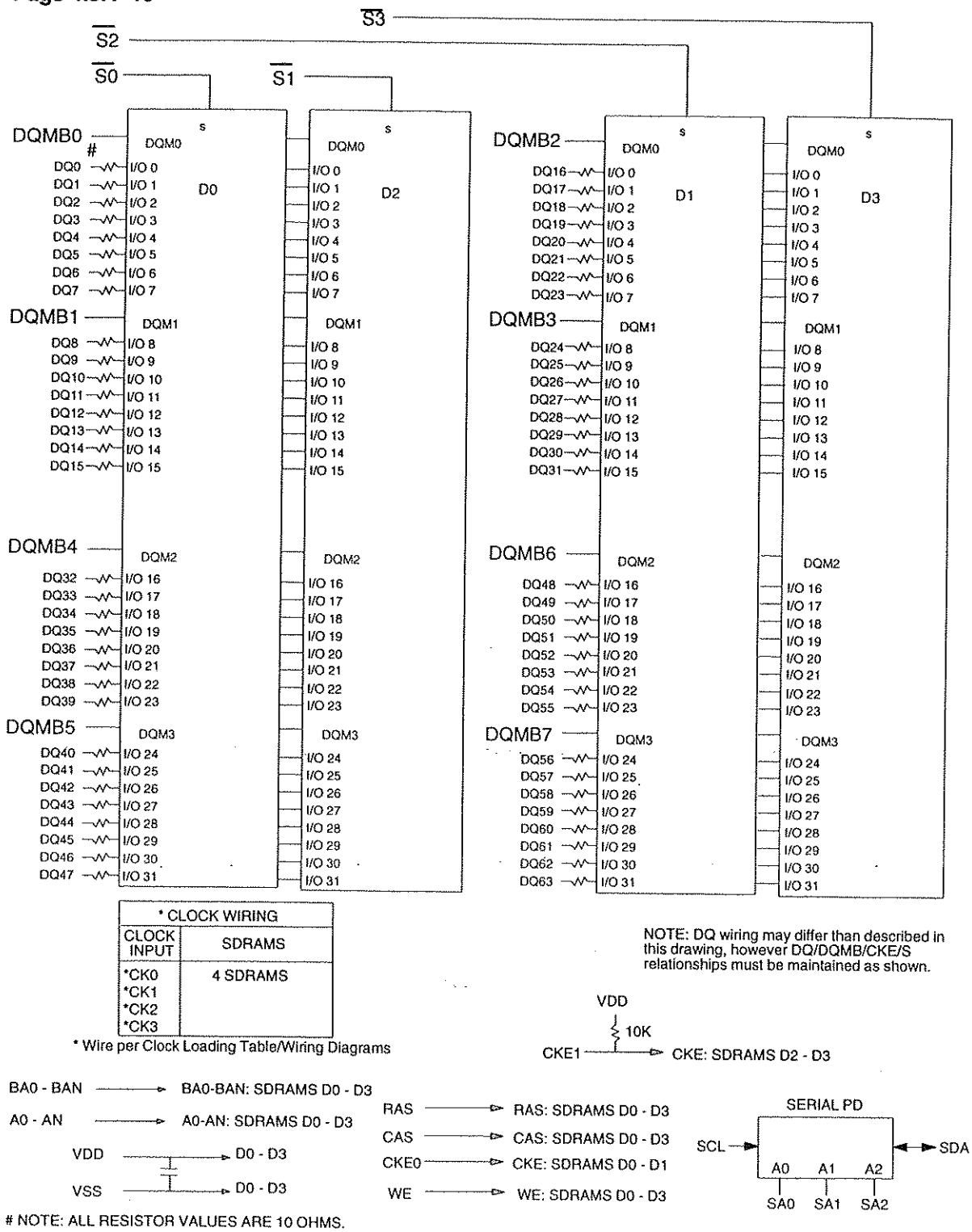
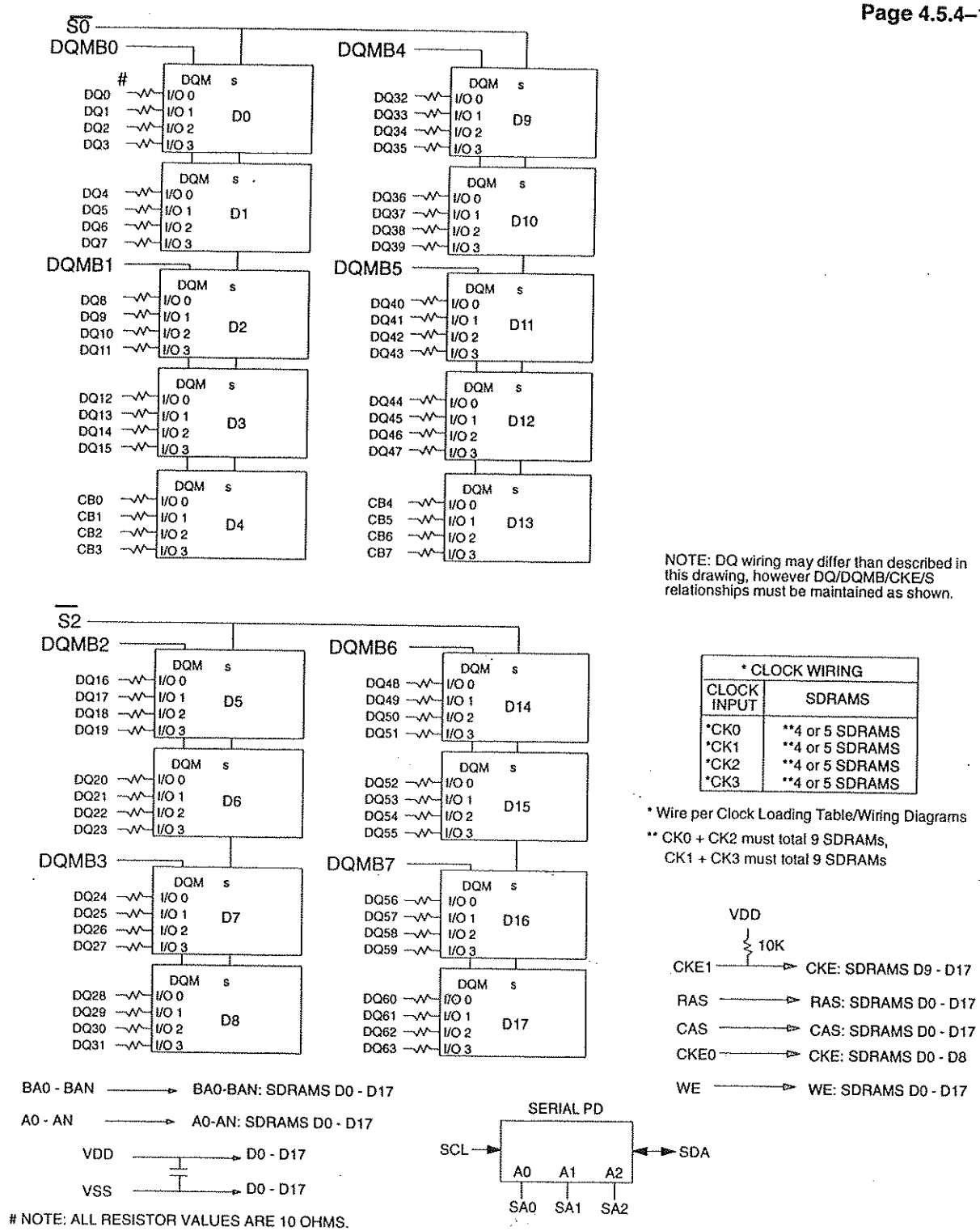



**Figure 4.5.4–O**
**X64 SDRAM DIMM, 2 Banks with X32 SDRAMs**

Release 7




## Figure 4.5.4–P
## X72 ECC SDRAM DIMM, 1 Banks with X4 SDRAMs

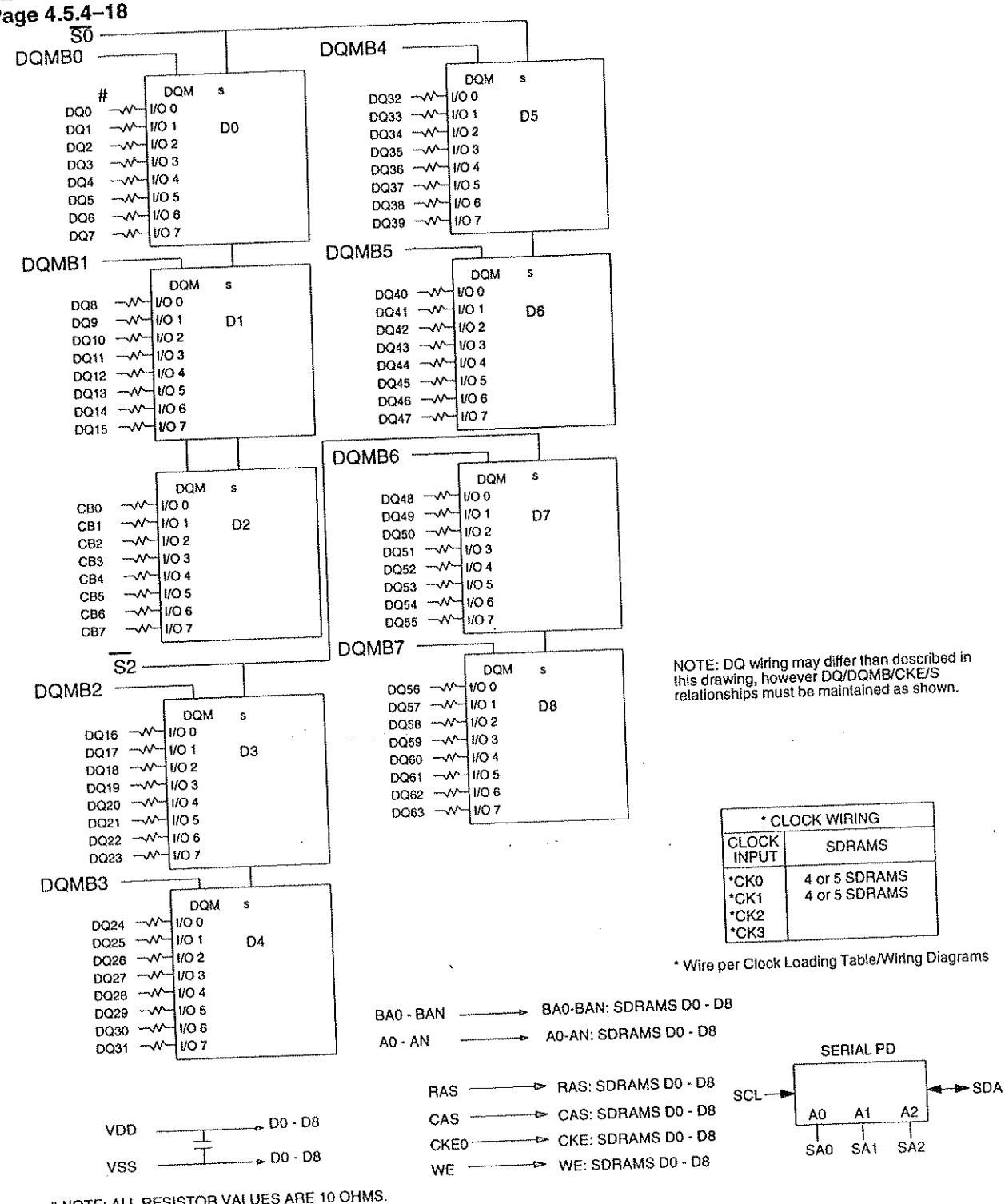
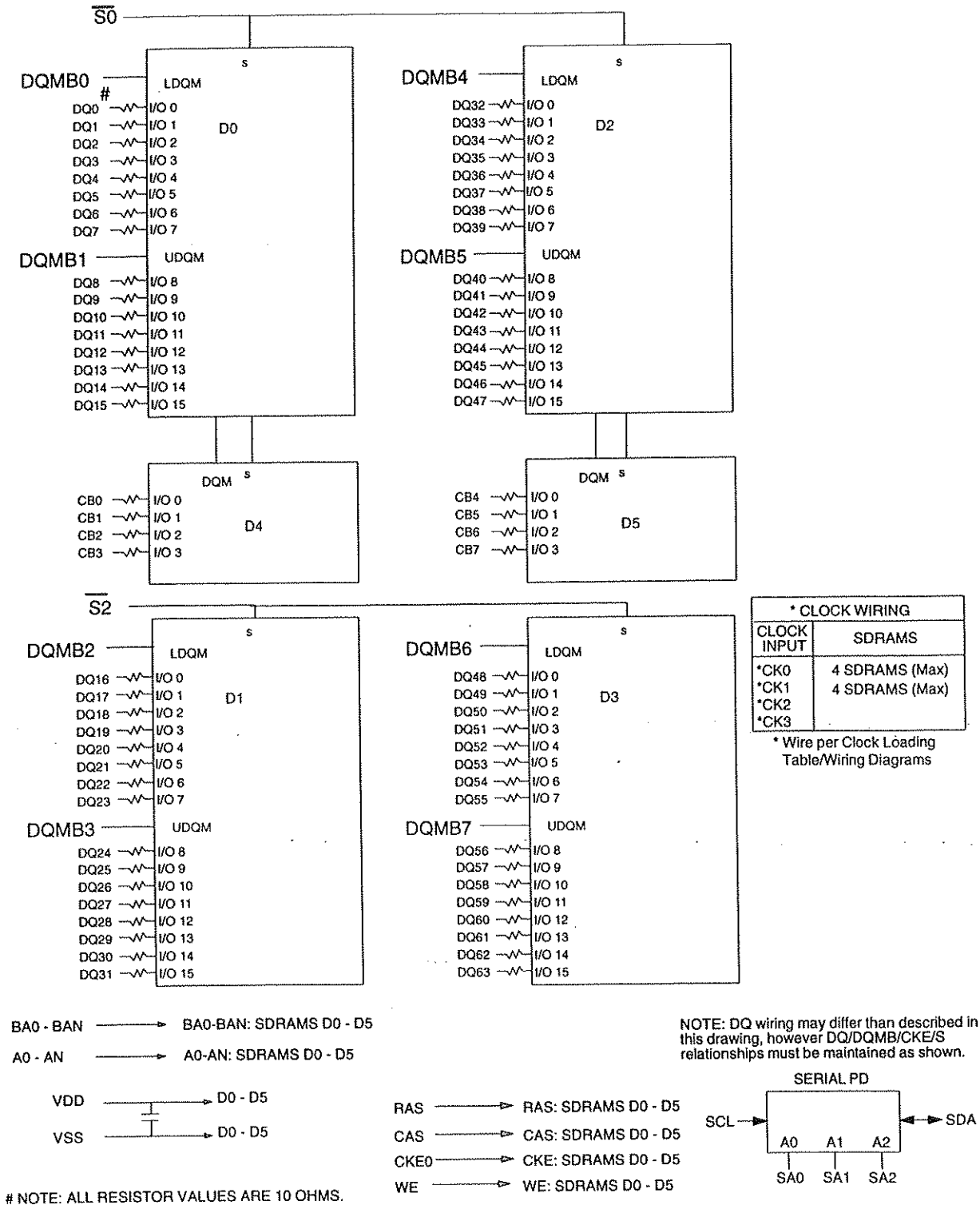



**Figure 4.5.4–Q**
**X72 ECC SDRAM DIMM, 1 Banks with X8 SDRAMs**




## Figure 4.5.4–R
## X72 ECC SDRAM DIMM, 1 Bank with X16 & X4 SDRAMs

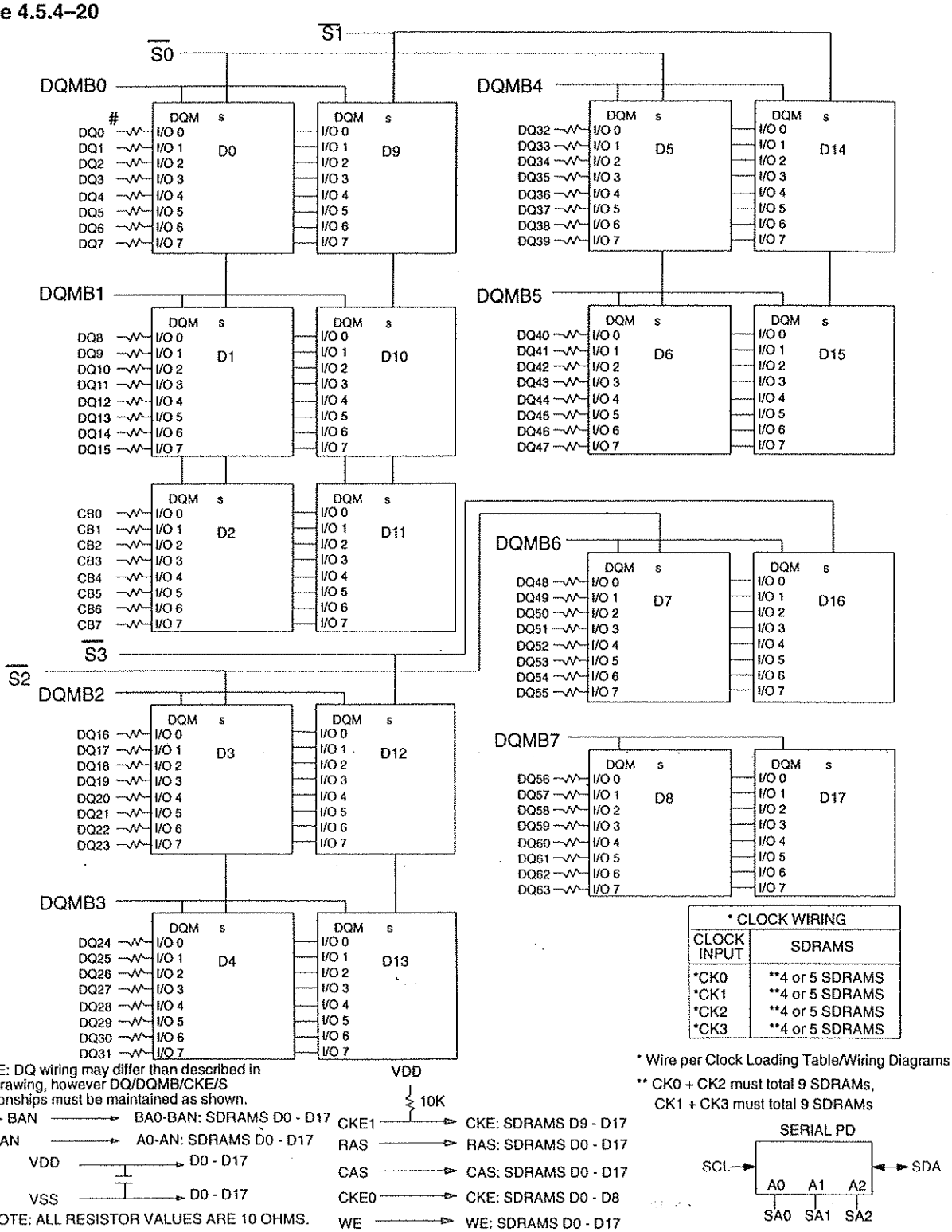



**Figure 4.5.4–S**
**X72 ECC SDRAM DIMM, 2 Banks with X8 SDRAMs**

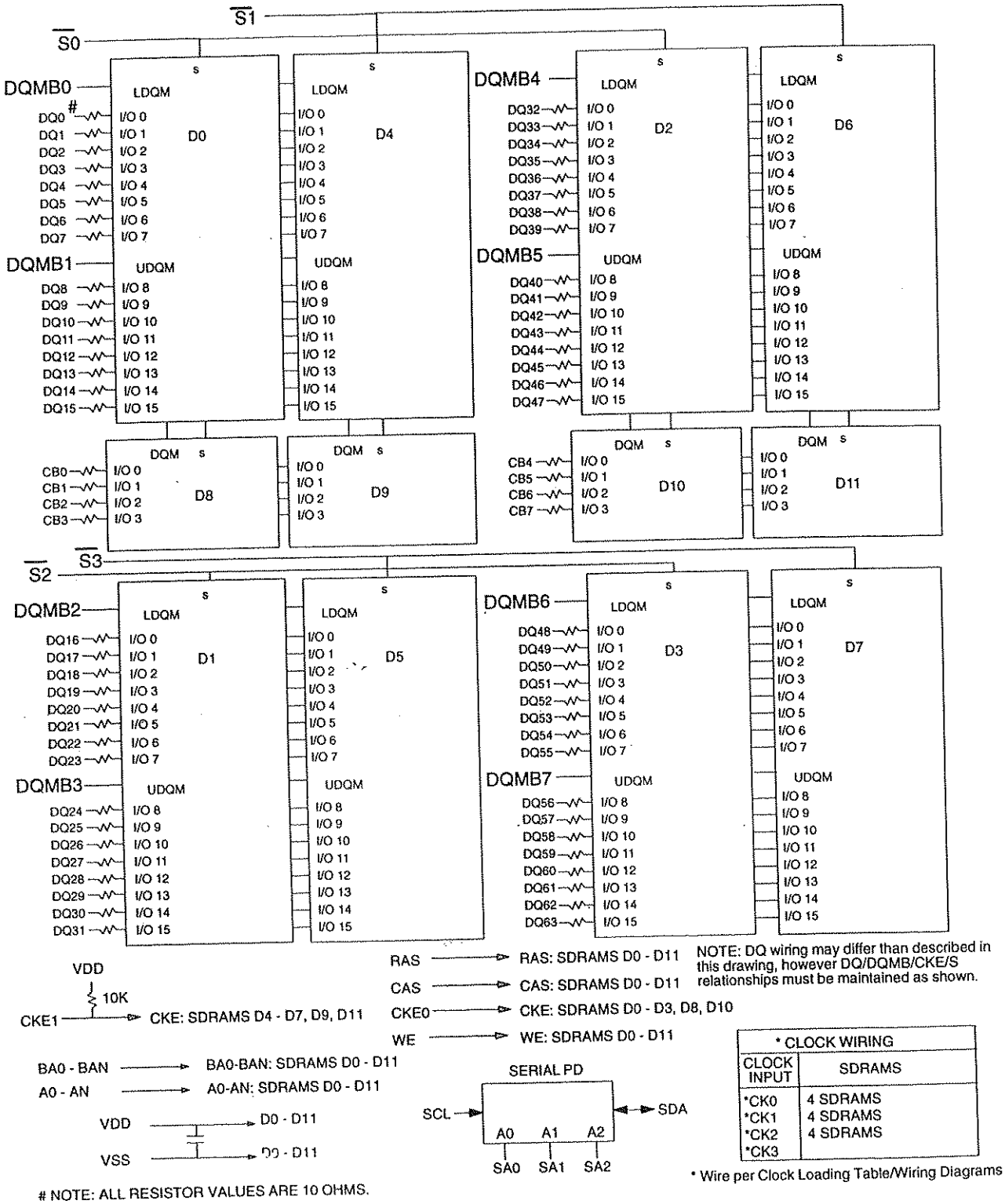



**Figure 4.5.4–T**
**X72 ECC SDRAM DIMM, 2 Banks with X16 & X4 SDRAMs**

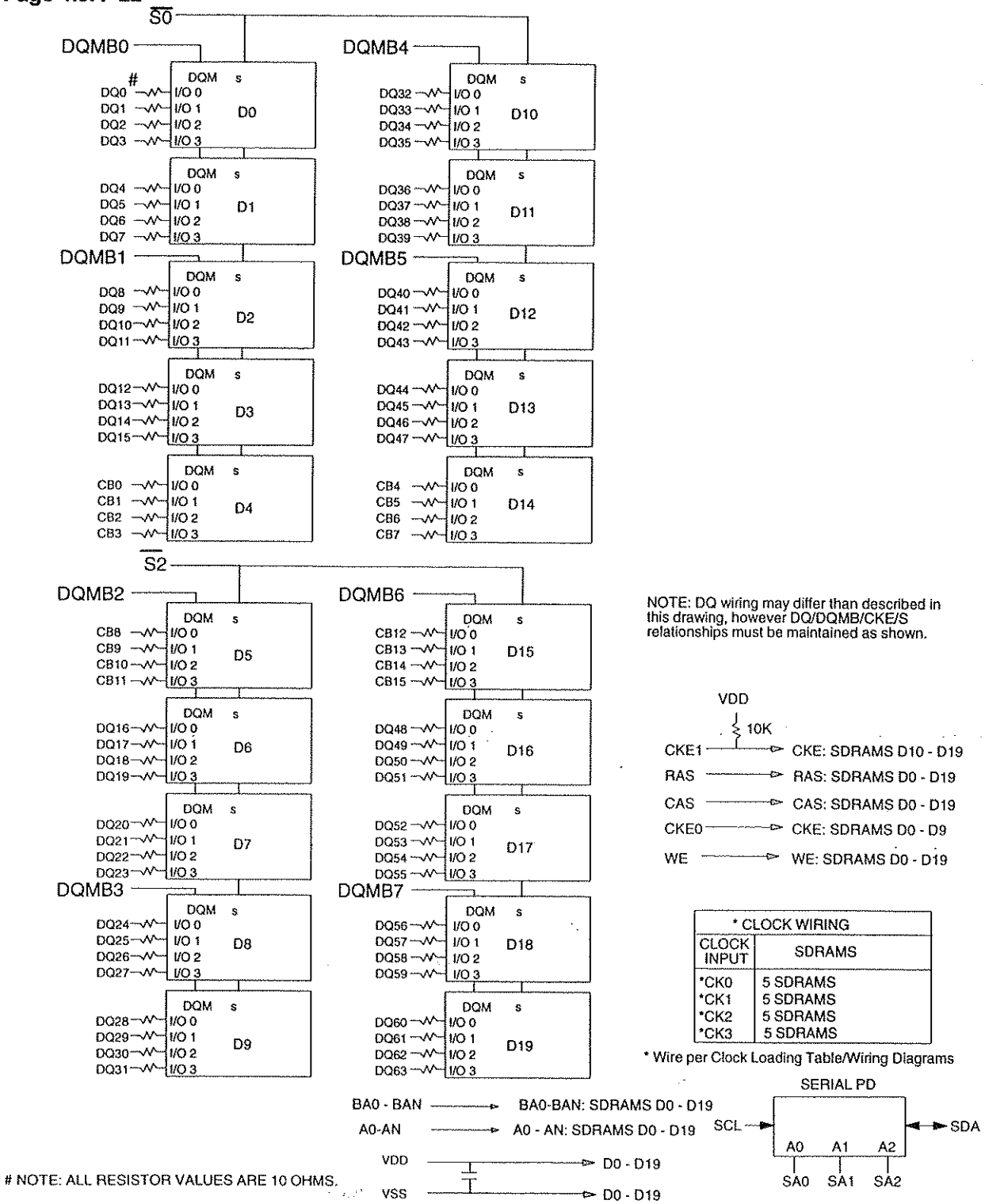



**Figure 4.5.4–U**
**X80 SDRAM DIMM, 1 Bank with X4 SDRAMs**

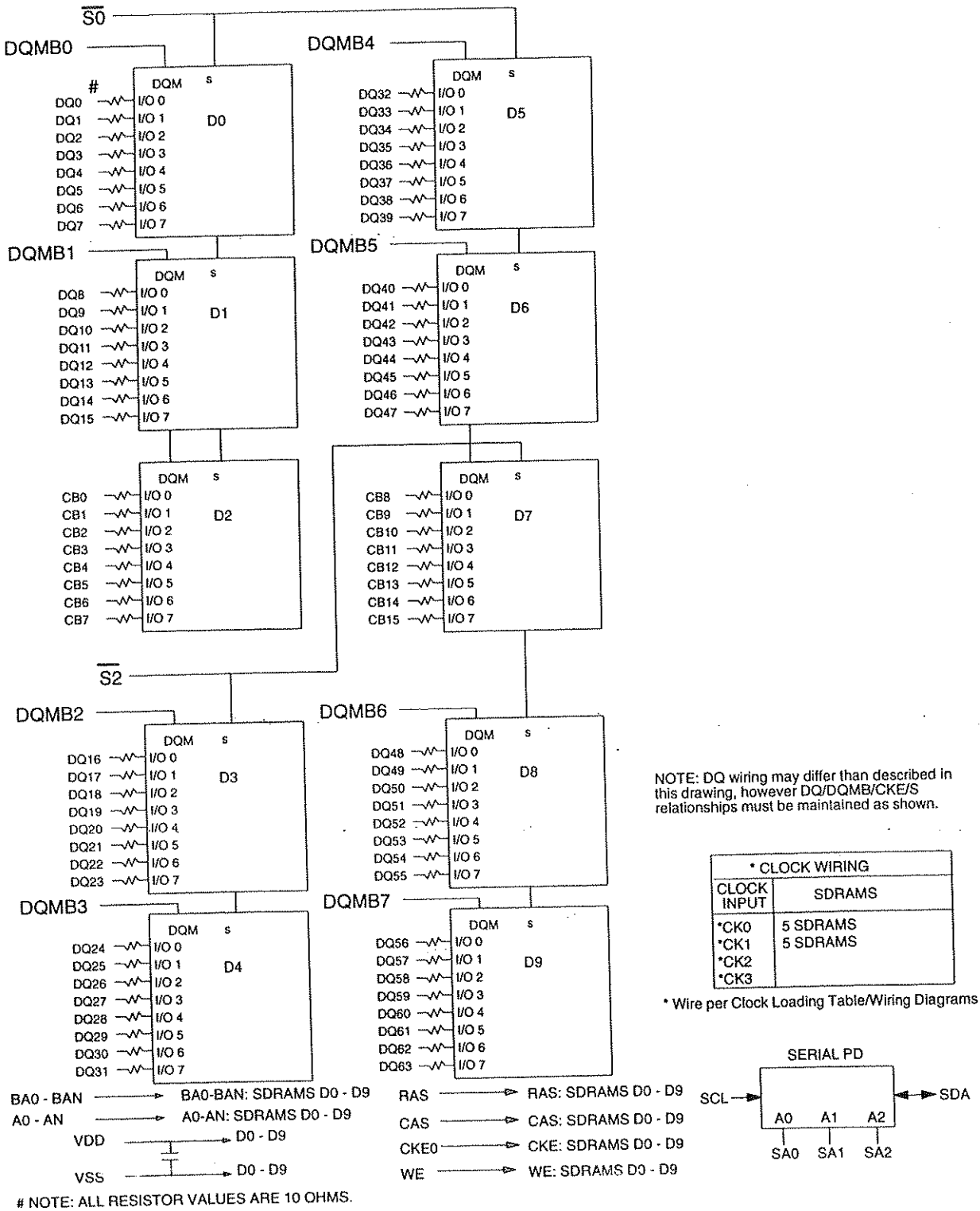



**Figure 4.5.4–V**
**X80 ECC SDRAM DIMM, 1 Bank with X8 SDRAMs**

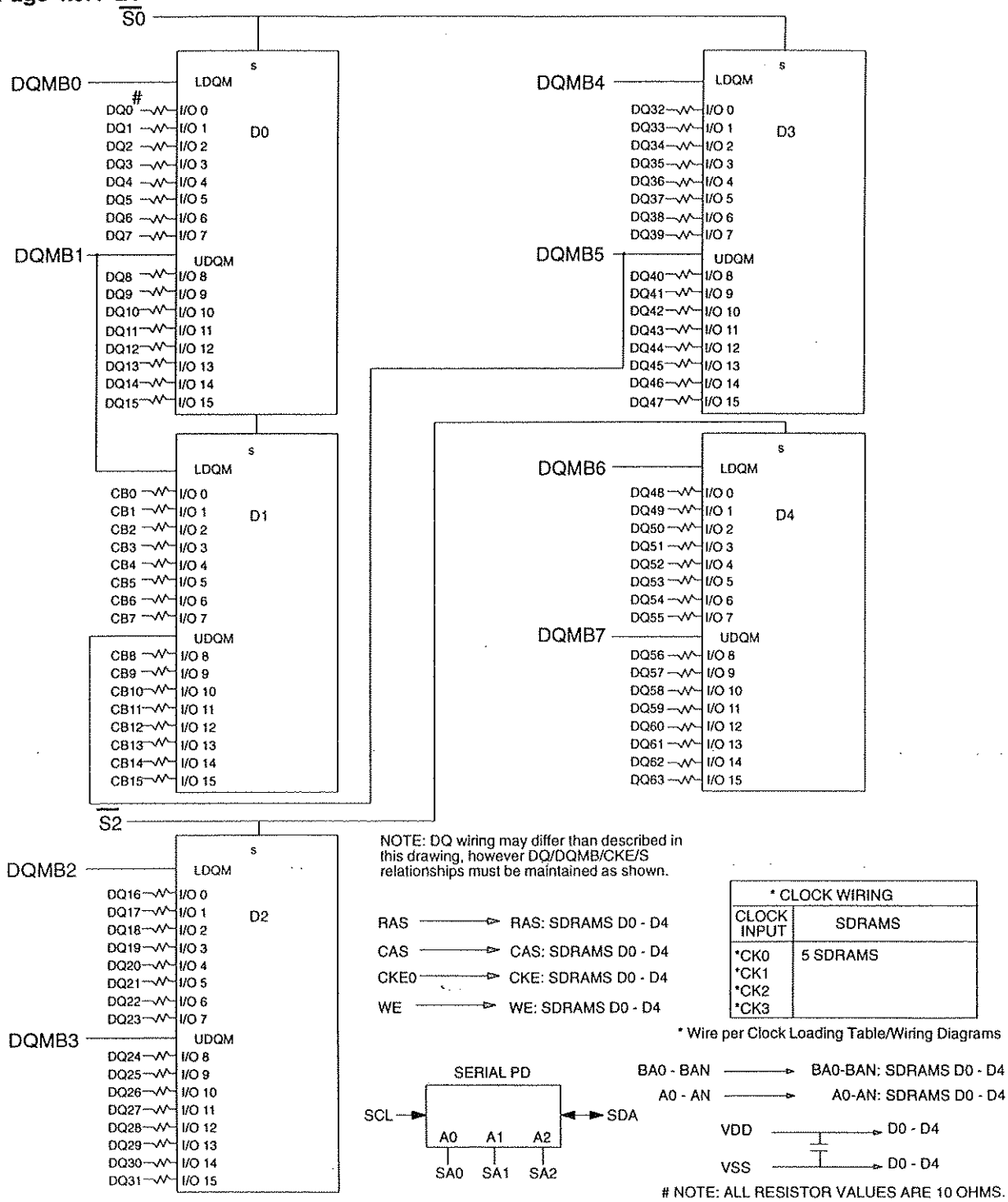



**Figure 4.5.4–W**
**X80 ECC SDRAM DIMM, 1 Bank with X16 SDRAMs**

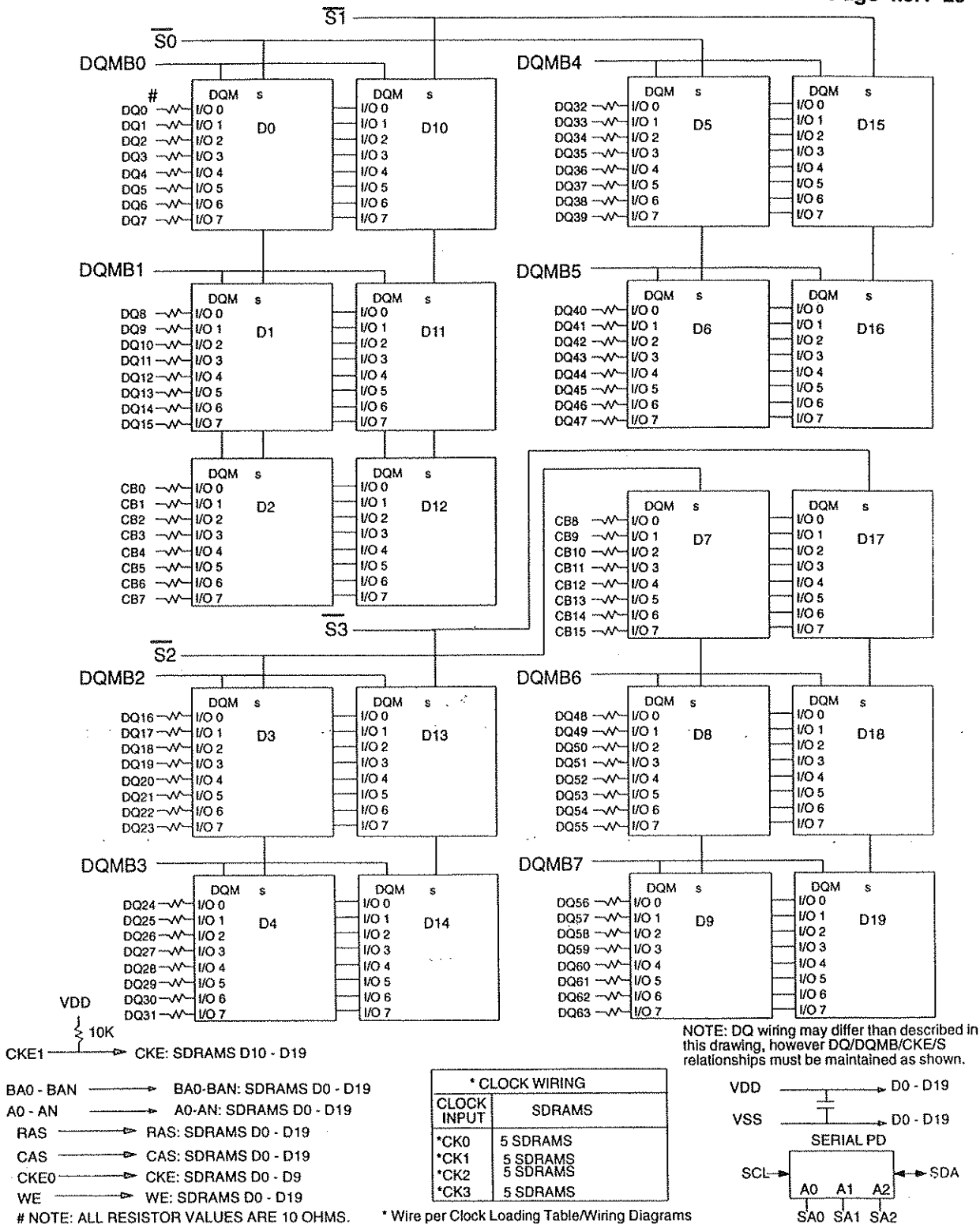



**Figure 4.5.4–X**
**X80 ECC SDRAM DIMM, 2 Banks with X8 SDRAMs**

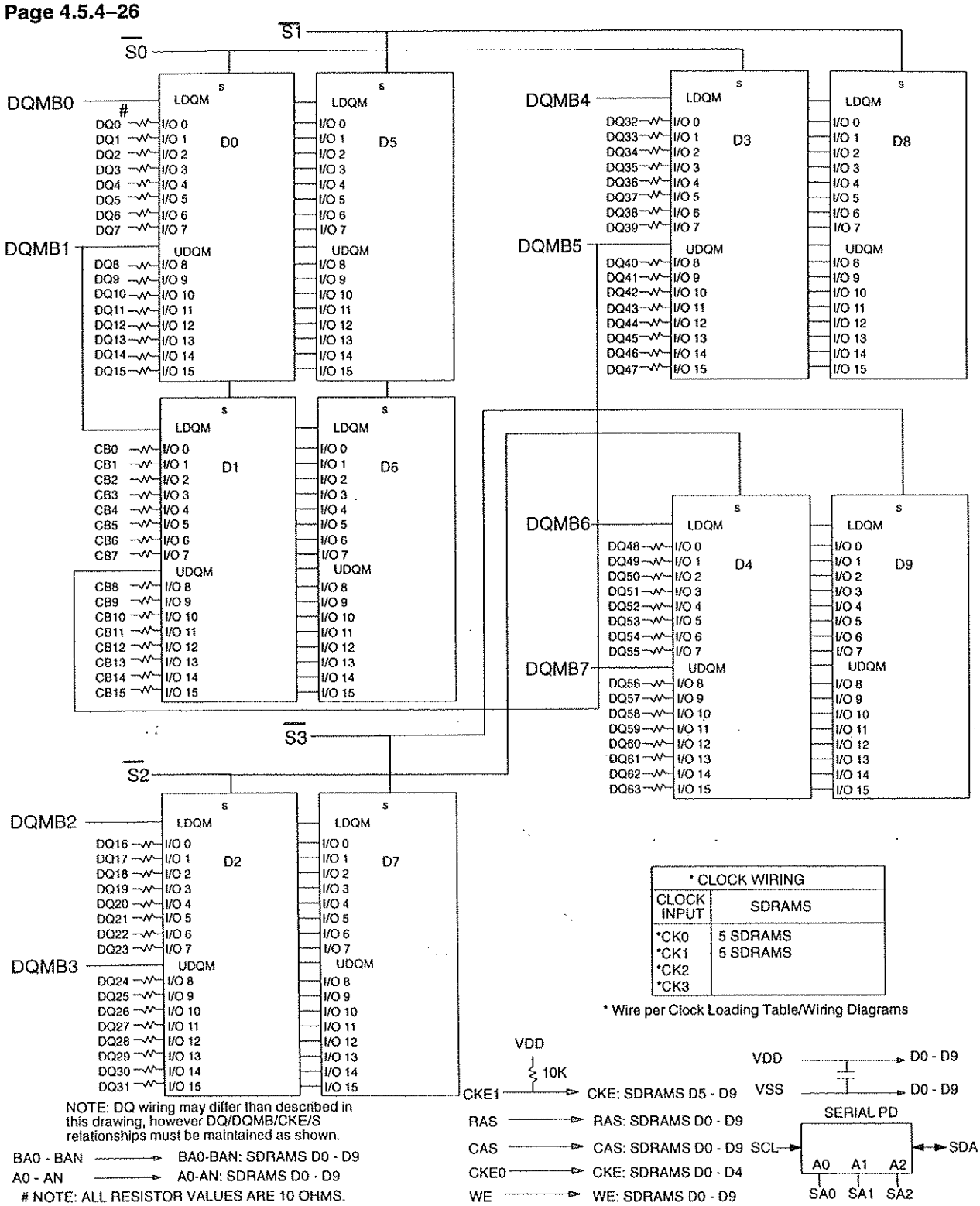



**Figure 4.5.4–Y**
**X80 ECC SDRAM DIMM, 2 Banks with X16 SDRAMs**

## 4.5.5 – 144 PIN DRAM SO–DIMM FAMILY

**NOTE:** It is recommended that this module be used primarily for main memory applications. At the time this standard was published, the Committee was working on a standard for a Graphics 144 Pin Module to be published in the near future.

CAPACITY—up to the addressing capacity of 16 bits, address multiplexed with words of 32, 36, & 40 bits.

DATA CONFIGURATIONS—Two DATA Word configurations are defined:
—64 BIT DRAM without PARITY
—72 BIT DRAM for ECC CODES

CONFIGURATION—10 Different Configurations are defined using various combinationa of X4, X8, and X16 DRAM memories including 2 bank configurations, 5 for 64 bit and 5 for 72 bit.

LOGIC FEATURES—The modules contain the Serial Presence Detect (SPD) feature that consist of a built in serial access EEPROM that stores information on mutiple parameters and attributes of the module such as technology, storage capacity, configuration, data word configuration, refresh mode, and speed of the module.

PACKAGE—144 PIN JEDEC SO–DIMM MEMORY MODULE

PIN ASSIGNMENTS —Figs. 4.5.5–A & 4.5.5–B

MODULE PIN NUMBERING AND KEYING METHODOLOGY — Fig. 4.5.5–C

TECHNOLOGY COMPARISON TABLE — Fig. 4.5.5–D

DRAM SPD INFORMATOION — Fig. 4.5.5–E

X64 DRAM CONFIGURATION BLOCK DIAGRAMS —Figs. 4.5.5–F through 4.5.5–J

X72 DRAM CONFIGURATION BLOCK DIAGRAMS —Figs. 4.5.5–K through 4.5.5–O

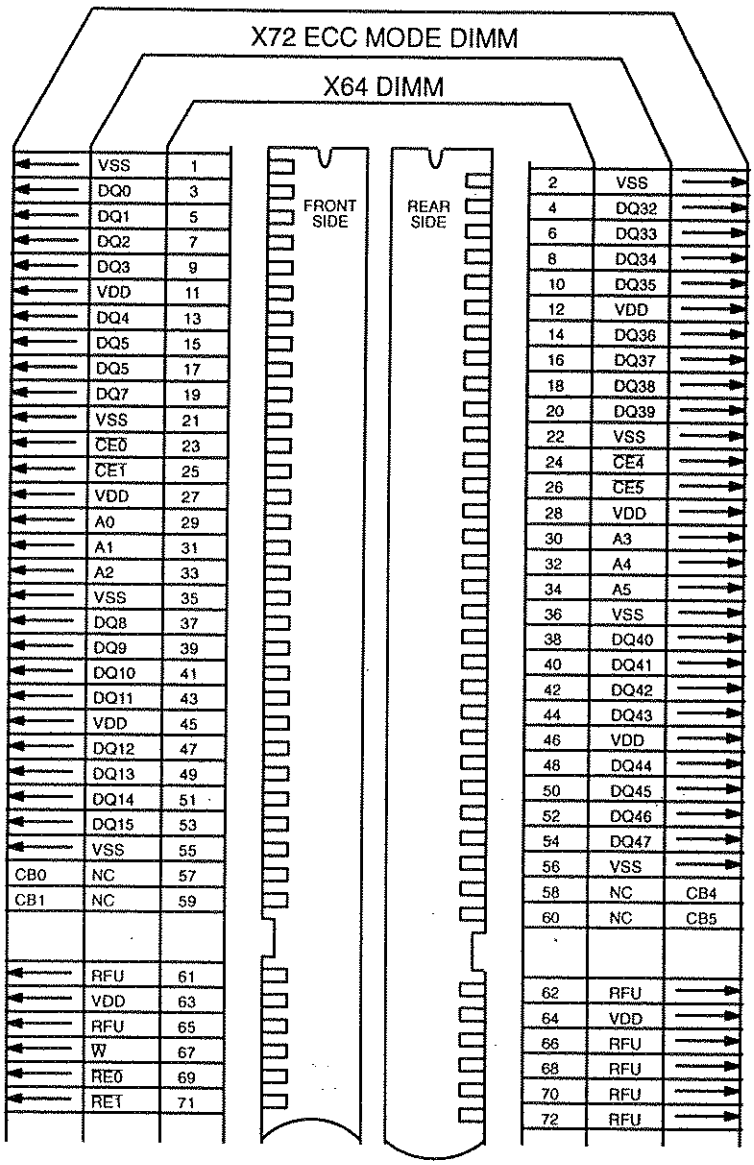



**Figure 4.5.5–A**
**144 Pin X64 & X72 DRAM SO–DIMM, PIN ASSIGNMENTS**
**UPPER HALF**

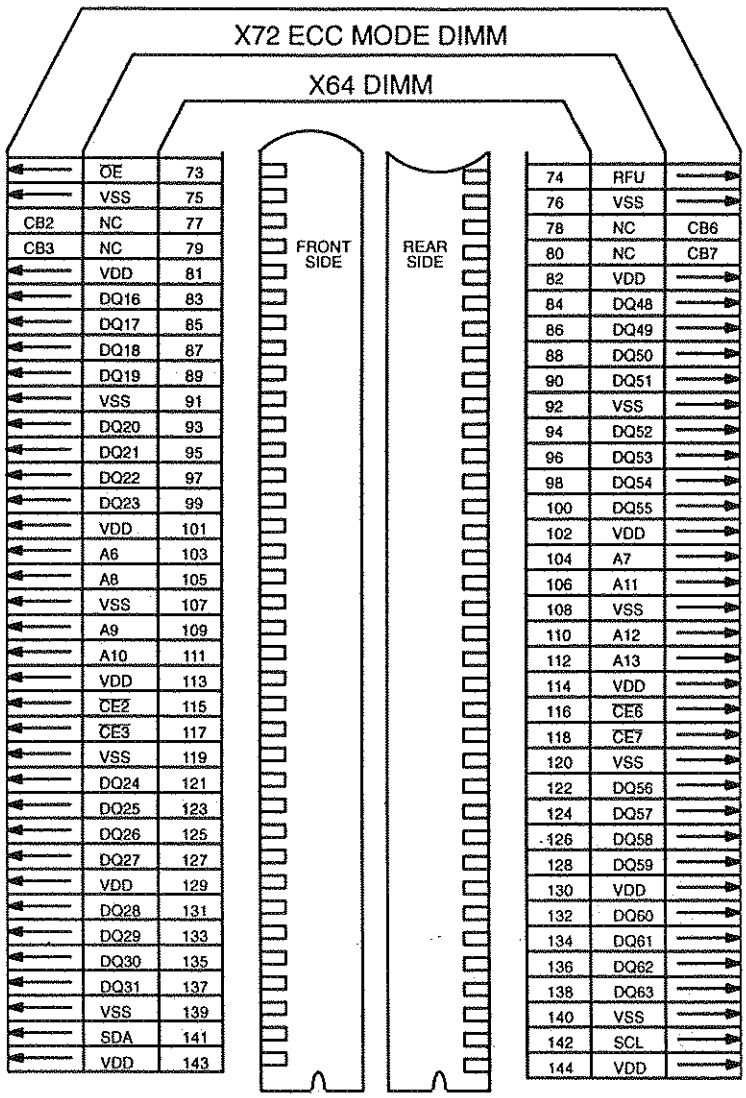



**Figure 4.5.5–B**
**144 Pin X64 & X72 DRAM SO–DIMM, PIN ASSIGNMENTS**
**LOWER HALF**

The diagram below shows the keying methodology employed on 8-byte SO DIMMs. The voltage key provides a positive interlock so that SO DIMMs can only be plugged into a system with the proper supply voltage, reducing potential damage to the module DRAM chips. Unless the designer chooses the appropriate connector, the system will not work.

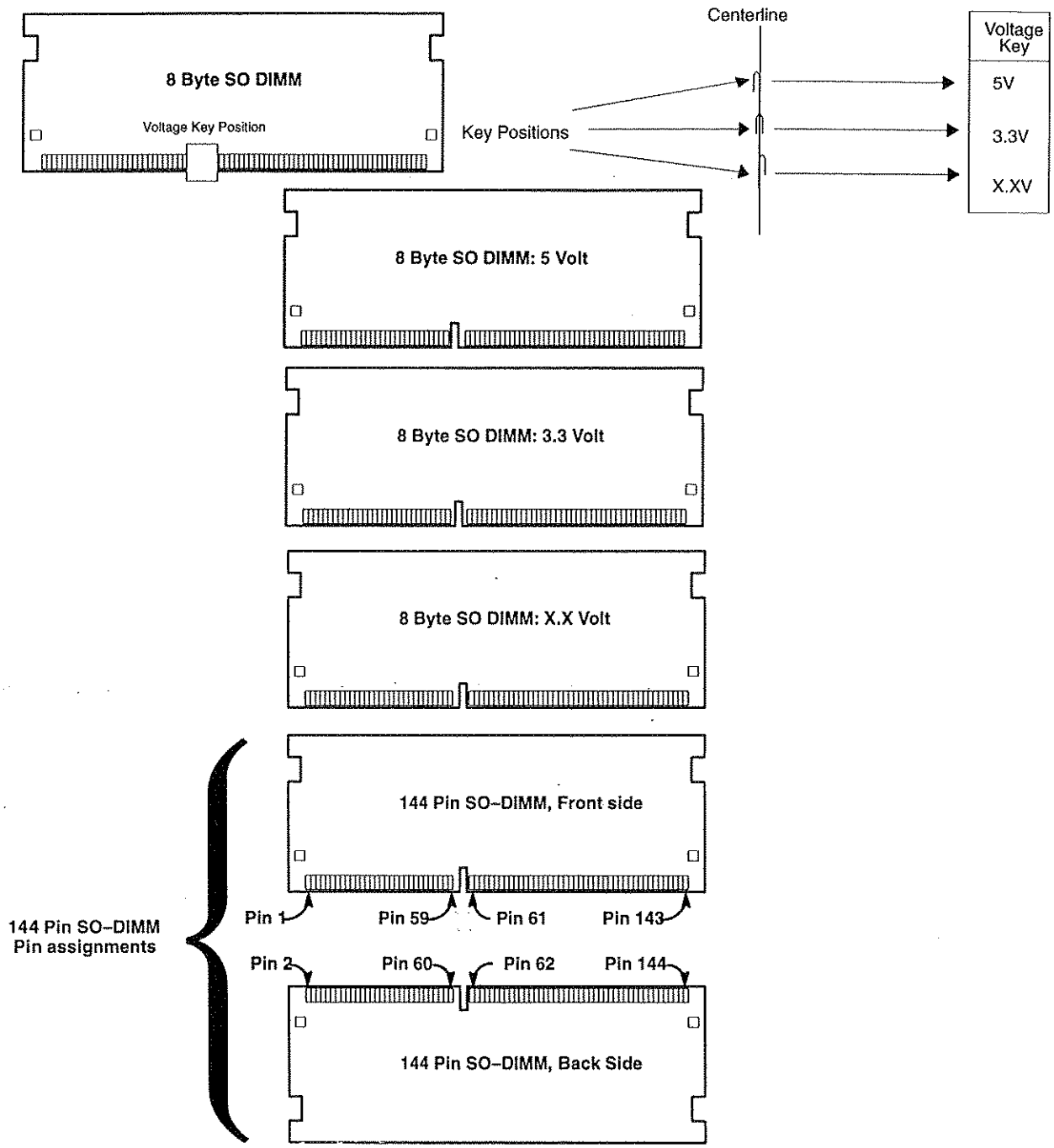



**Figure 4.5.5–C**
**144 Pin SO–DRAM DIMM Keying Methodology**

| Pin # | DRAM SODIMM | SDRAM SODIMM |
|---|---|---|
| 23 | $\overline{CAS0}$ | DQMB0 |
| 25 | $\overline{CAS1}$ | DQMB1 |
| | | |
| 61 | DU | CK0 |
| | | |
| 65 | DU | $\overline{RAS}$ |
| | | |
| 69 | $\overline{RAS0}$ | $\overline{S0}$ |
| 71 | $\overline{RAS1}$ | $\overline{S1}$ |
| 73 | $\overline{OE}$ | DU |
| | | |
| 111 | A10 | A10/AP |
| | | |
| 115 | $\overline{CAS2}$ | DQMB2 |
| 117 | $\overline{CAS3}$ | DQMB3 |
| | | |
| 24 | $\overline{CAS4}$ | DQMB4 |
| 26 | $\overline{CAS5}$ | DQMB5 |
| | | |
| 62 | DU | CKE0 |
| | | |
| 66 | DU | $\overline{CAS}$ |
| 68 | NC | CKE1 |
| 70 | NC | A12 |
| 72 | NC | A13, DSF |
| | | |
| 74 | NC | CK1 |
| | | |
| 106 | A11 | BA0 |
| | | |
| 110 | A12 | BA1 |
| 112 | A13 | A11 |
| | | |
| 116 | $\overline{CAS6}$ | DQMB6 |
| 118 | $\overline{CAS7}$ | DQMB7 |

**Figure 4.5.5–D**
**Pinout Comparison, 144 Pin DRAM & SDRAM SO–DIMM**

## 8 Byte DRAM SO–DIMM PD Information

- Serial PD Interface Protocol: $I^2C$ (Synchronous 2-Wire Bus)
- The following information is to be written into EEPROM device during module production:
  a. Module Configurations, Addressing: (Bytes 3-7)

| Module Configuration | DRAM Organization | Option 1 | | Option 2 | | Option 3 | |
|---|---|---|---|---|---|---|---|
| | | $\overline{RAS}$ Addr. | $\overline{CAS}$ Addr. | $\overline{RAS}$ Addr. | $\overline{CAS}$ Addr. | $\overline{RAS}$ Addr. | $\overline{CAS}$ Addr. |
| 512K x 64/72 | 512K x 8 | 10 | 9 | | | | |
| 1M x 64/72 | 512K x 8 | 10 | 9 | | | | |
| 1M x 64/72 | 1M x 4/16 | 10 | 10 | 12 | 8 | | |
| 2M x 64/72 | 1M x 16 | 10 | 10 | 12 | 8 | | |
| 2M x 64/72 | 2M x 8 | 11 | 10 | 12 | 9 | | |
| 4M x 64/72 | 2M x 8 | 11 | 10 | 12 | 9 | | |
| 4M x 64/72 | 4M x 4/16 | 11 | 11 | 12 | 10 | *13 | 9 |
| 8M x 64/72 | 4M x 16 | 11 | 11 | 12 | 10 | *13 | 9 |
| 8M x 64/72 | 8M x 8 | 12 | 11 | 13 | 10 | | |
| 16M x 64/72 | 8M x 8 | 12 | 11 | 13 | 10 | | |
| 16M x 64/72 | 16M x 4/16 | 12 | 12 | 13 | 11 | *14 | 10 |
| 32M x 64/72 | 16M x 16 | 12 | 12 | 13 | 11 | *14 | 10 |
| 32M x 64/72 | 32M x 8 | 13 | 12 | 14 | 11 | | |
| 64M x 64/72 | 32M x 8 | 13 | 12 | 14 | 11 | | |
| 64M x 64/72 | 64M x 4 | 13 | 13 | 14 | 12 | | |
| (Note: All options possible with DRAM standards are shown)<br>* This addressing option applies to x16 DRAM configuration | | | | | | | |

  b. Allowable configurations: (Byte 11)
     - x64 (Non-parity, Byte controls)
     - x72 (ECC-optimized, Byte controls)
  c. Functional Attributes:
     - Power Supply Voltage/Interface levels (Byte 8)
     - $\overline{RAS}$ access (Byte 9)
     - $\overline{CAS}$ access (Byte 10)
     - Refresh rate/type (Byte 12)

For Detailed Serial PD Byte data see section 4–?–?, DRAM Serial Presence Detect Definitions.

1. Serial PD interface is standard $I^2C$ architecture
2. Pull-up resistors (4.7K typical value) are required on all open drain/open collector bus devices (SCL and SDA).
3. Current sink capability on SCL and SDA source ($I_{OL}$ max) must be at least 3ma to maintain a valid "low level".
4. $I^2C$ Bus specification:

## Figure 4.5.5–E
## 144 Pin X64 DRAM SO–DIMM, SPD TABLE AND INFORMATION

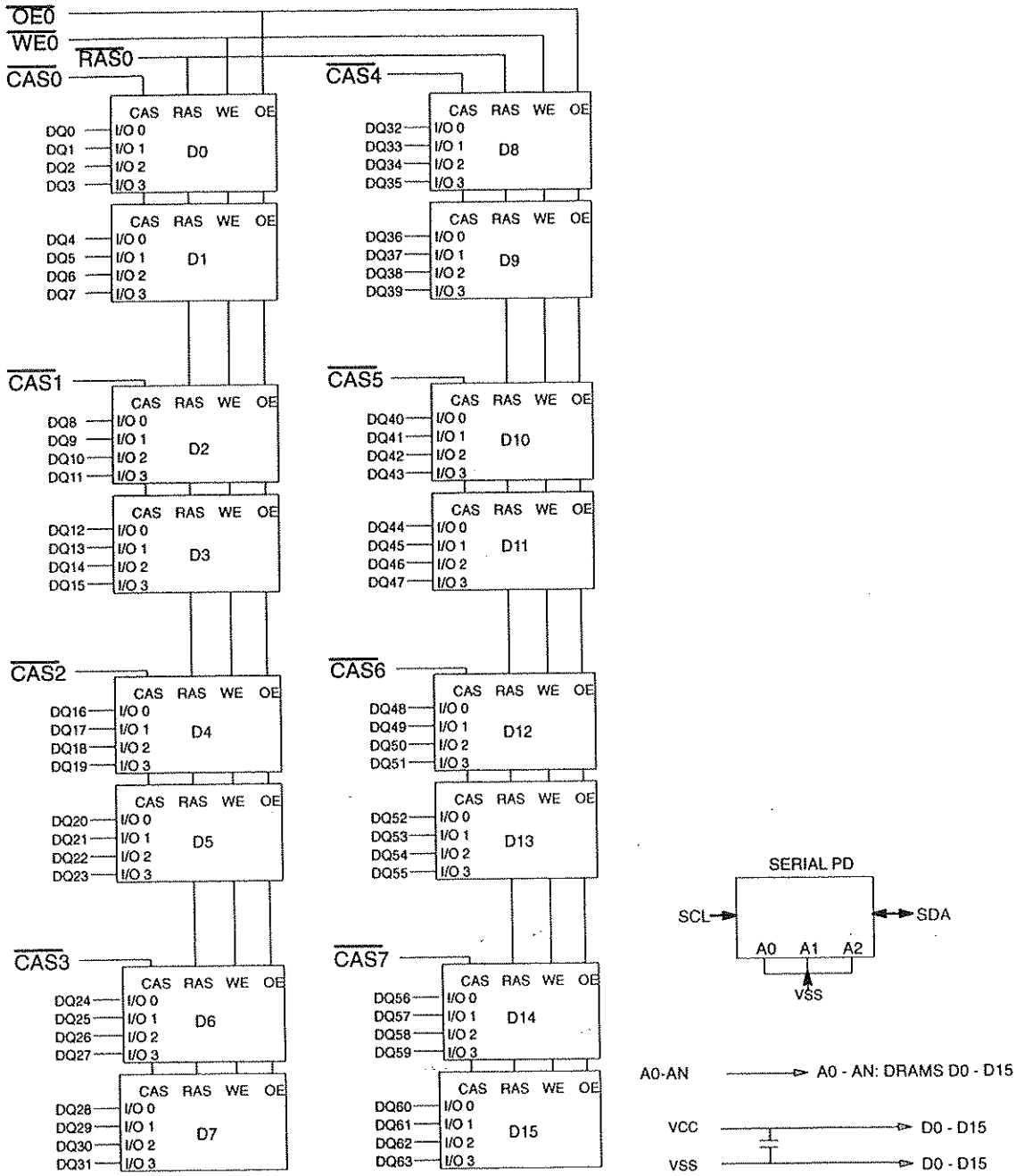



**Figure 4.5.5–F**
**144 Pin X64 DRAM SO–DIMM, 1 Bank with X4 DRAMs**

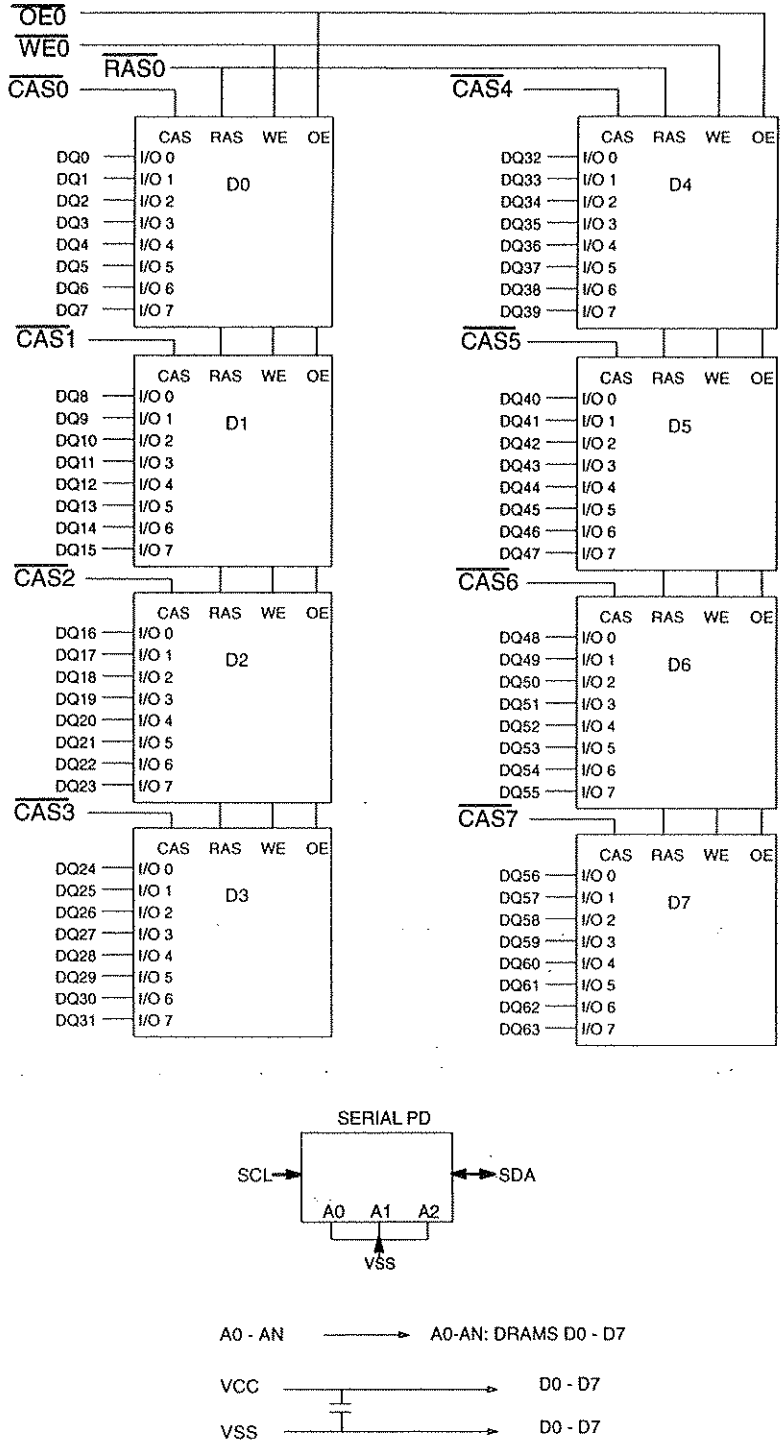



**Figure 4.5.5–G**
**144 Pin X64 DRAM SO–DIMM, 1 Bank with X8 DRAMs**

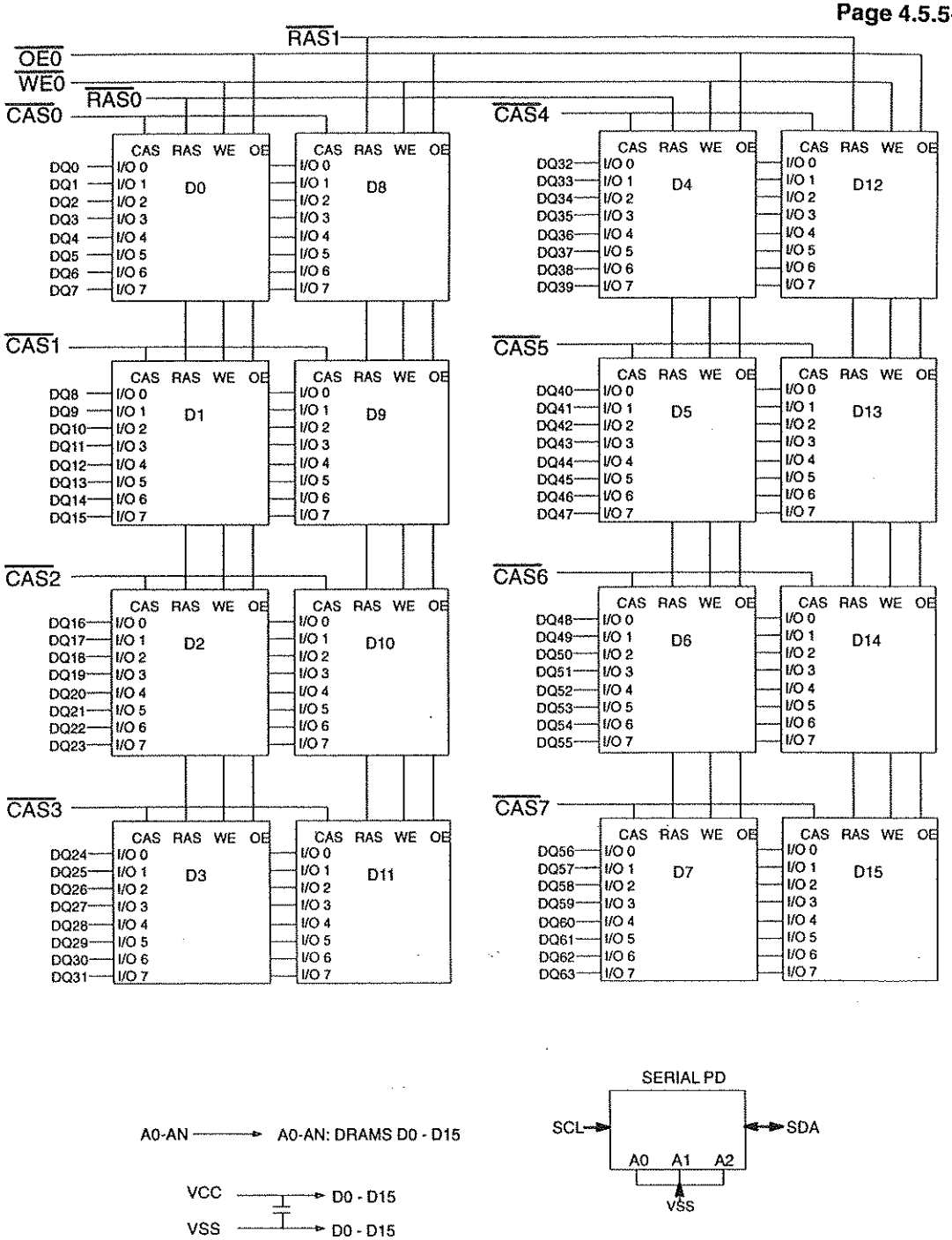



**Figure 4.5.5–H**
**144 Pin X64 DRAM SO–DIMM, 2 Bank with X8 DRAMs**

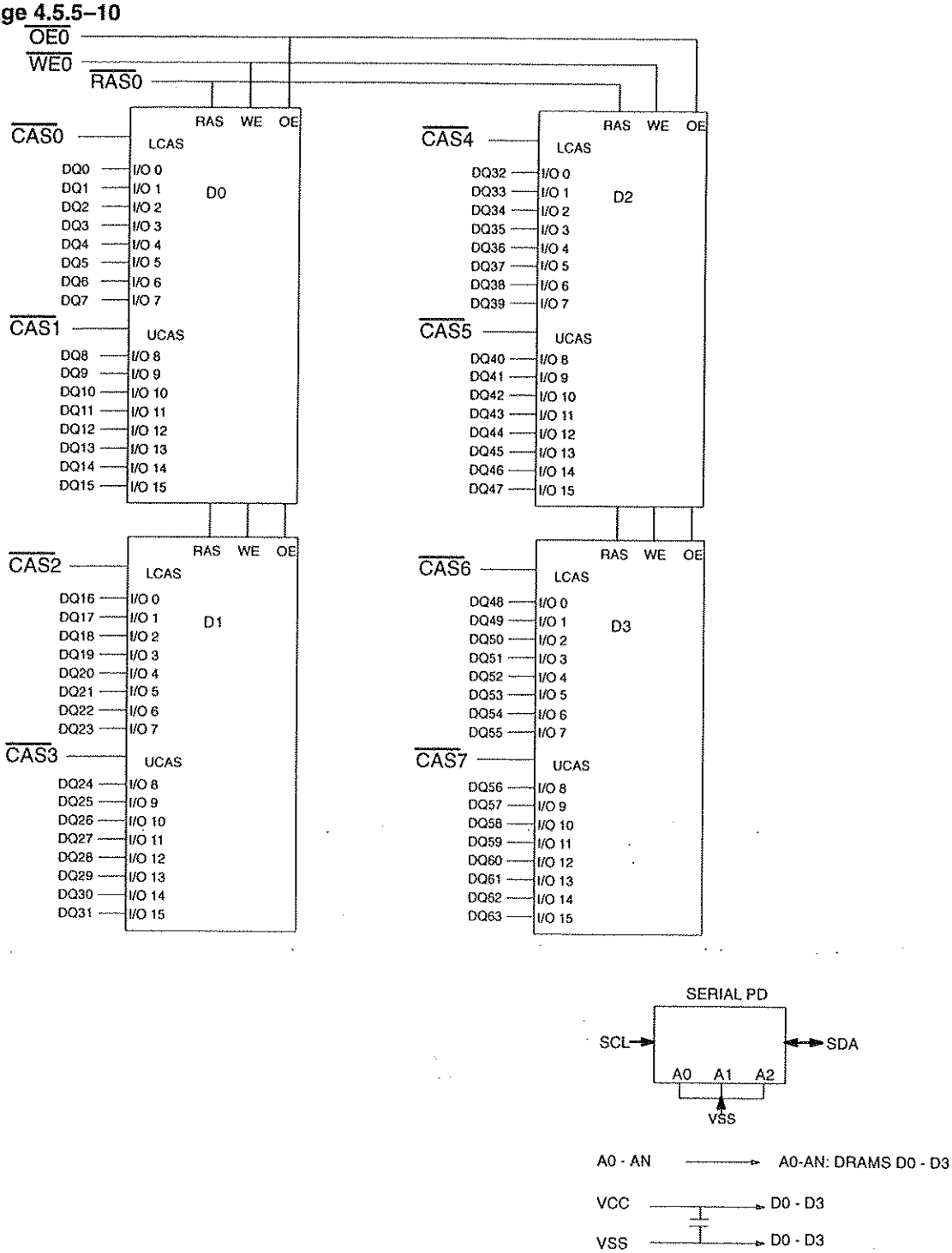



**Figure 4.5.5–I**
**144 Pin X64 DRAM SO–DIMM, 1 Bank with X16 DRAMs**

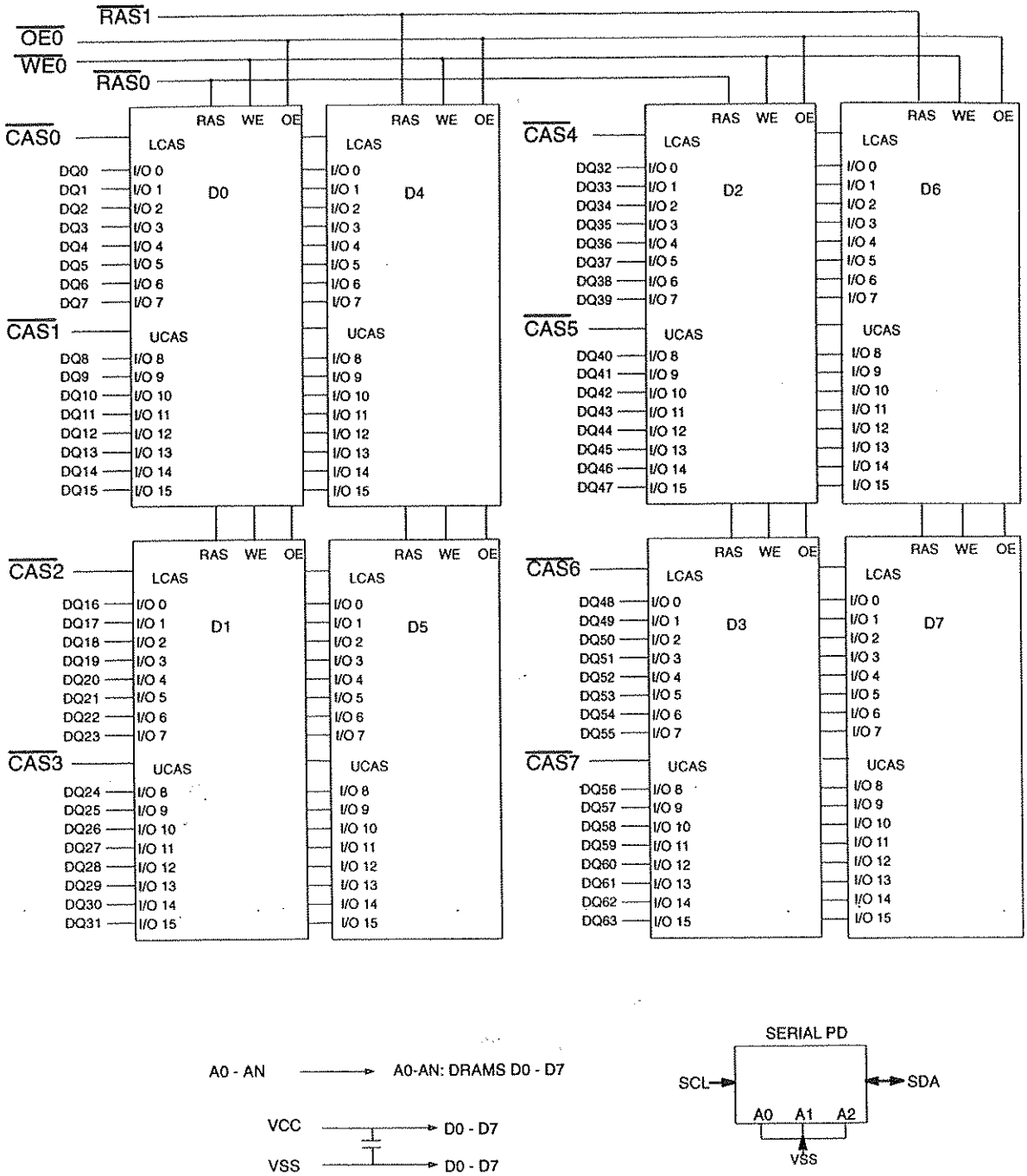
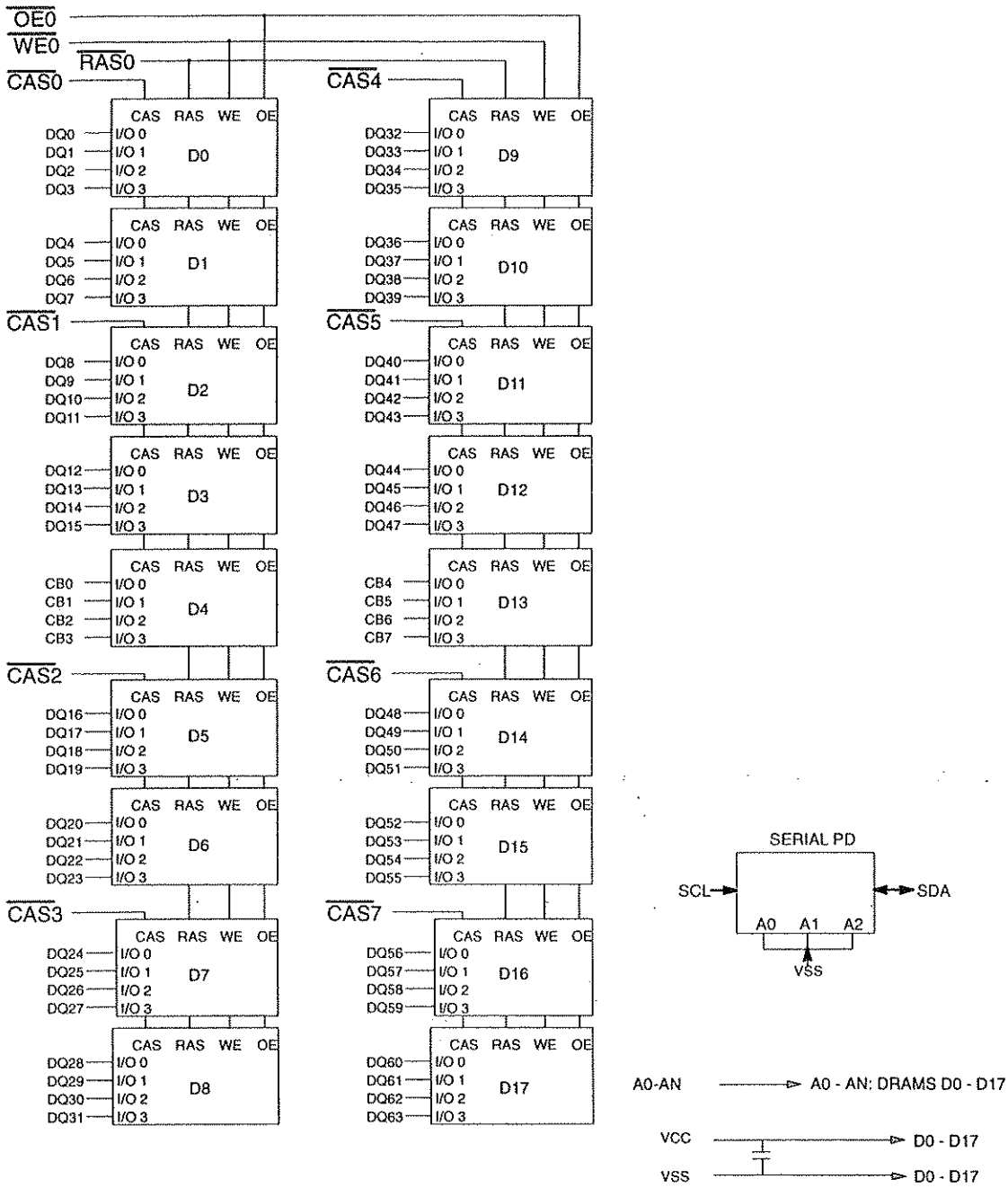



**Figure 4.5.5–J**
**144 Pin X64 DRAM SO–DIMM, 2 Bank with X16 DRAMs**




## Figure 4.5.5–K
## 144 Pin X72 ECC DRAM SO–DIMM, 1 Bank with X4 DRAMs



XILINX EXHIBIT 1012
Page 416

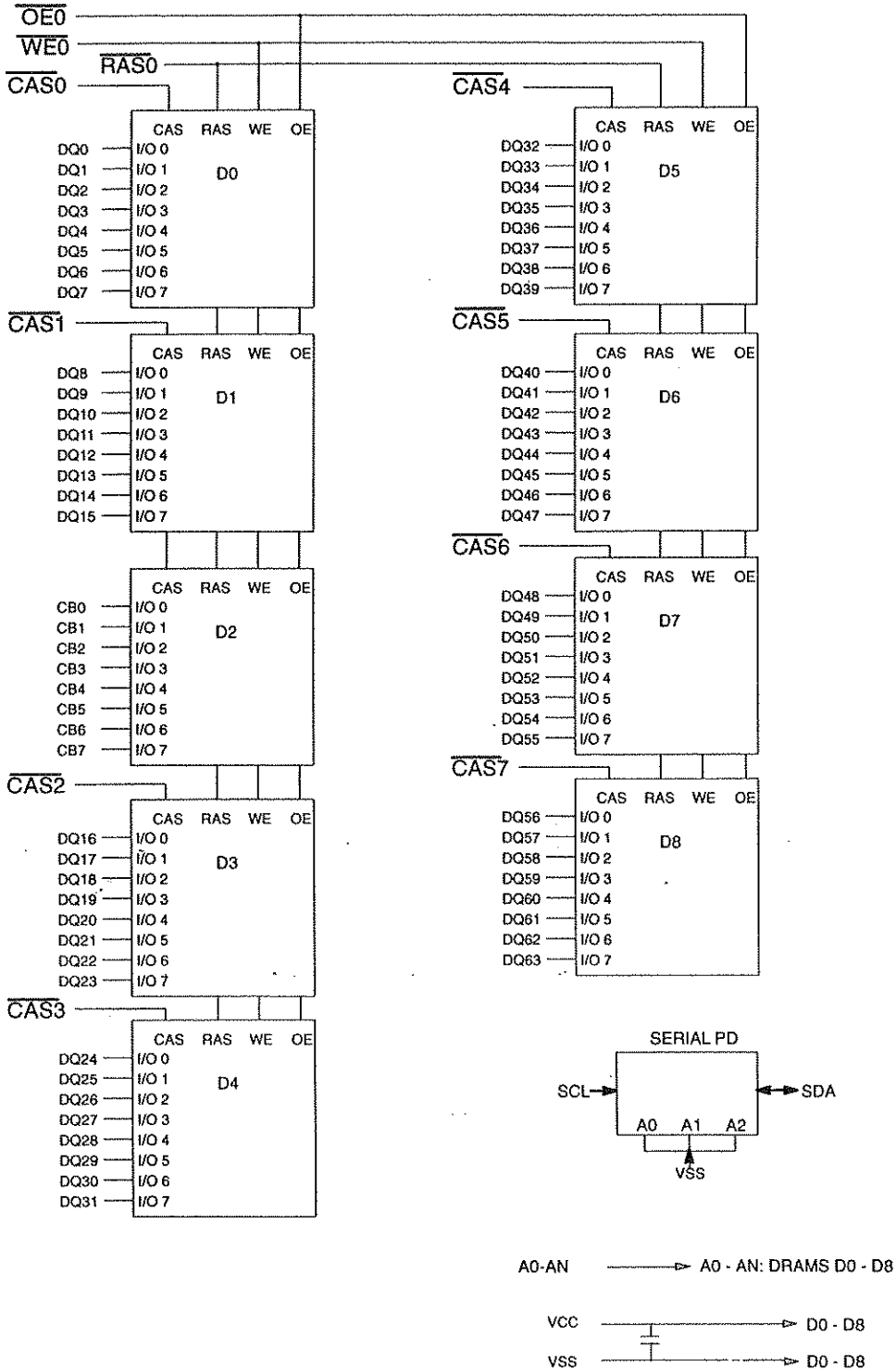



**Figure 4.5.5–L**
**144 Pin X72 ECC DRAM SO–DIMM, 1 Bank with X8 DRAMs**

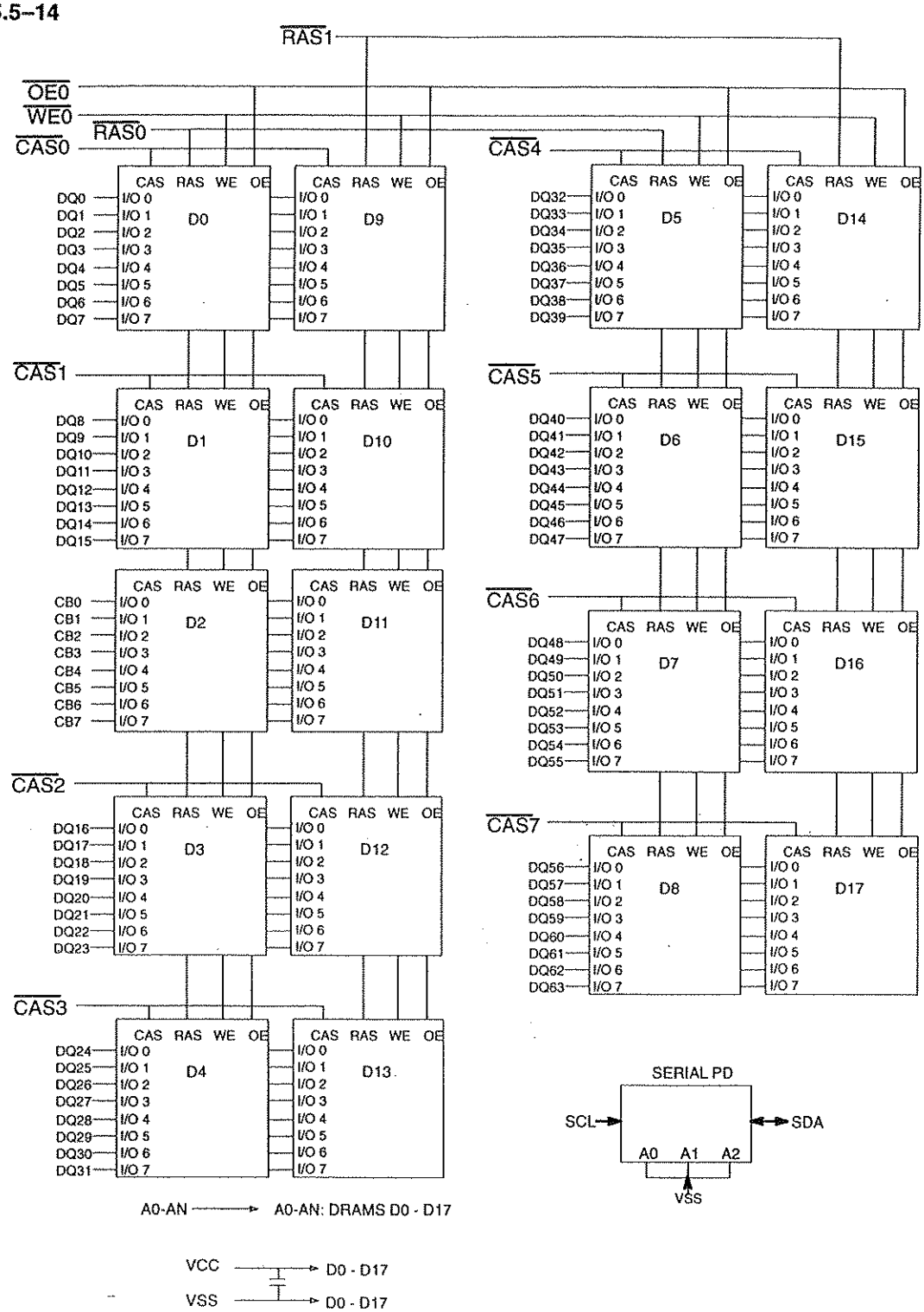



**Figure 4.5.5–M**
**144 Pin X72 ECC DRAM SO–DIMM, 2 Bank with X8 DRAMs**

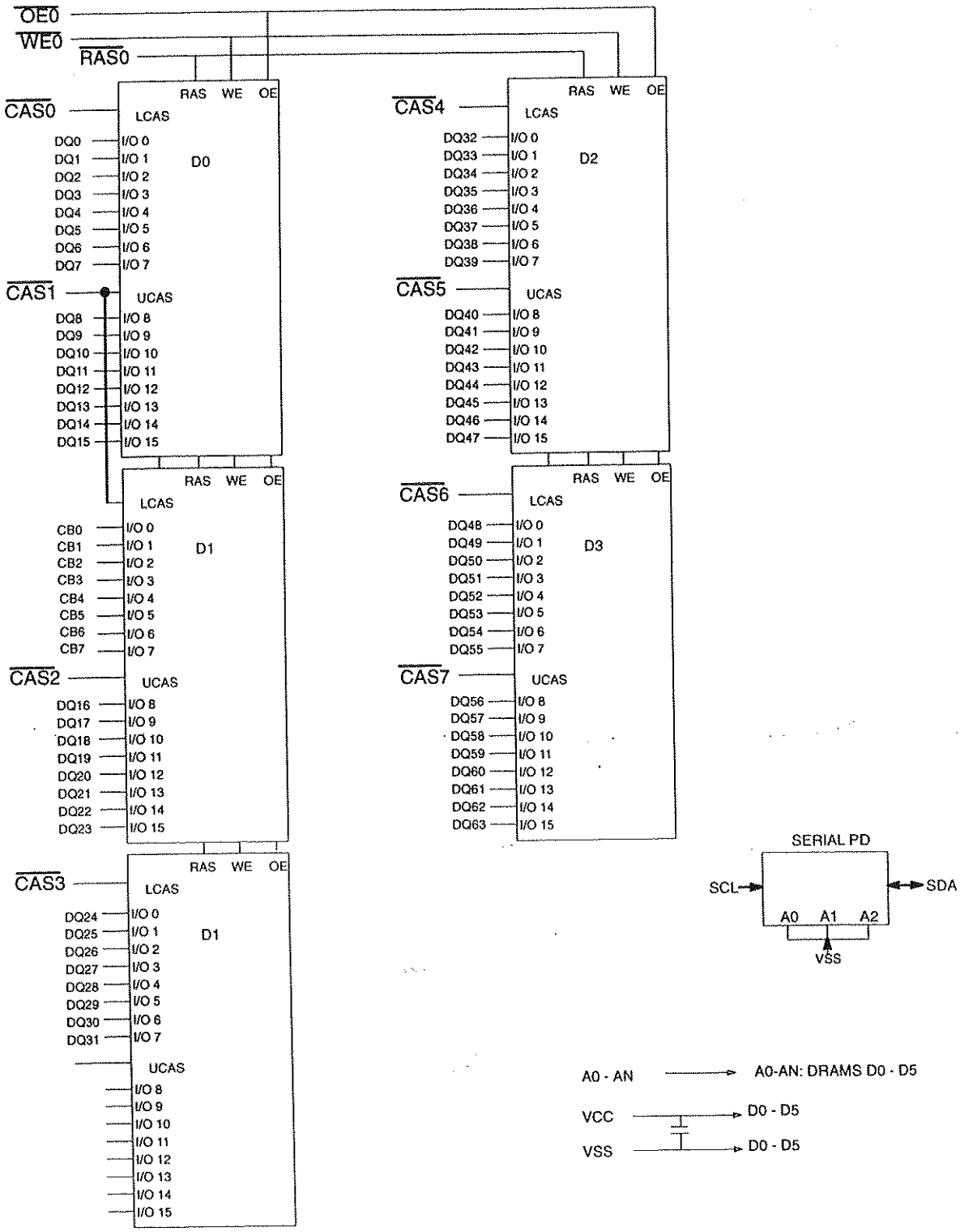



**Figure 4.5.5–N**
**144 Pin X72 ECC DRAM SO–DIMM, 1 Bank with X16 DRAMs**

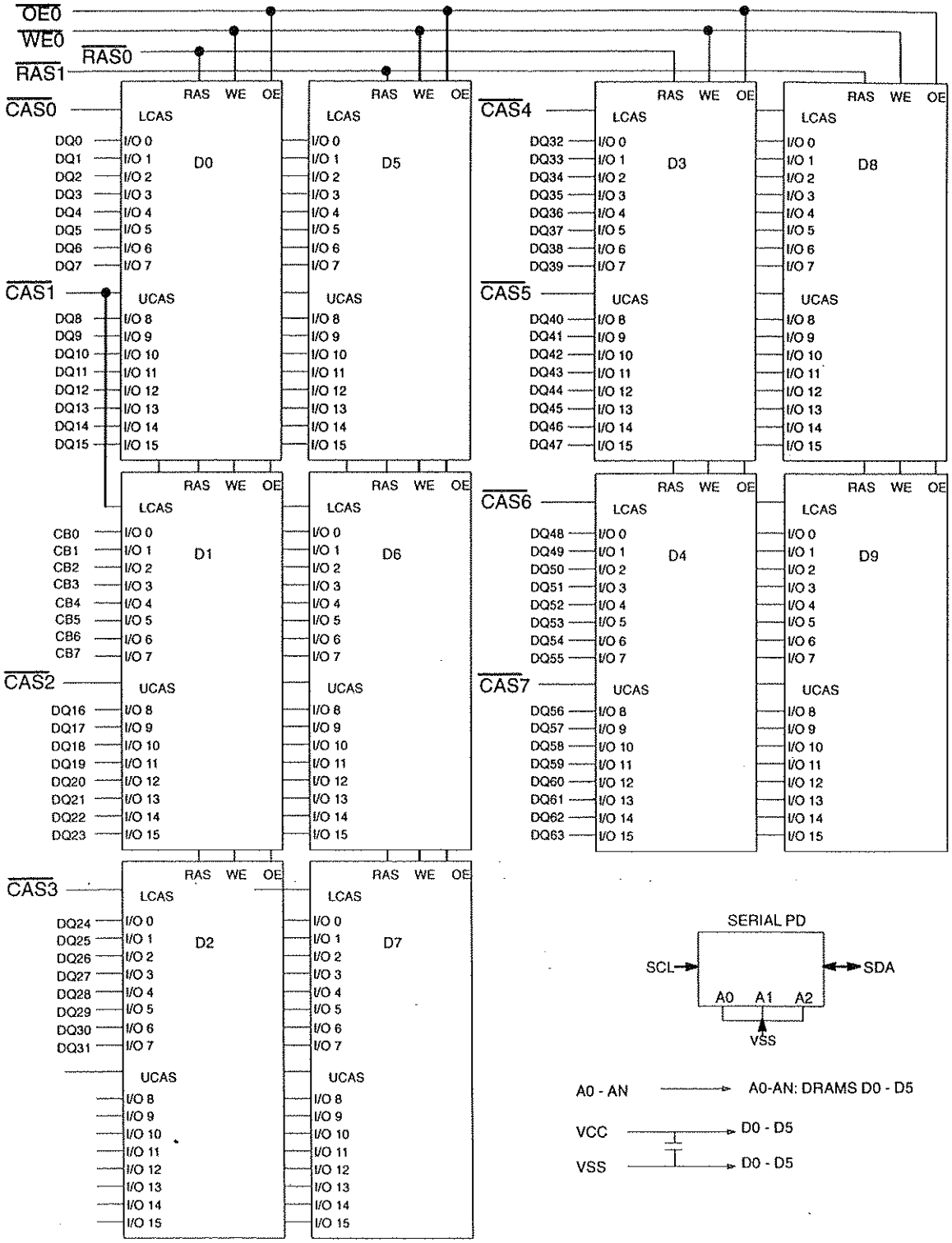



**Figure 4.5.5–O**
**144 Pin X72 ECC DRAM SO–DIMM, 2 Bank with X16 DRAMs**

## 4.5.6 – 144 PIN SDRAM SO–DIMM FAMILY

CAPACITY—up to the addressing capacity of 16 bits, address multiplexed with words of 32, 36, & 40 bits.
DATA CONFIGURATIONS—Two DATA Word configurations are defined:
—64 BIT SDRAM without PARITY
—72 BIT SDRAM for ECC CODES
CONFIGURATION—10 Different Configurations are defined using various combinationa of X4, X8, and X16 SDRAM memories including 2 bank configurations, 5 for 64 bit and 5 for 72 bit.
LOGIC FEATURES—The modules contain the Serial Presence Detect (SPD) feature that conist of a built in serial access EEPROM that stores information on mutiple parameters and attributes of the module such as technology, storage capacity, configuration, data word configuration, refresh mode, and speed of the module.
PACKAGE—144 PIN JEDEC SO–DIMM MEMORY MODULE
PIN ASSIGNMENTS —Figs. 4.5.6–A & 4.5.6–B
SDRAM SPD INFORMATOION — Fig. 4.5.6–C
MODULE PIN NUMBERING AND KEYING METHODOLOGY — Fig. 4.5.6–D
TECHNOLOGY COMPARISON TABLE — Fig. 4.5.6–E
SDRAM CLOCK LOADING & WIRING—Figs. 4.5.6–F
X64 SDRAM CONFIGURATION BLOCK DIAGRAMS —Figs. 4.5.6–G through 4.5.6–L
X72 SDRAM CONFIGURATION BLOCK DIAGRAMS —Figs. 4.5.6–M through 4.5.6–P

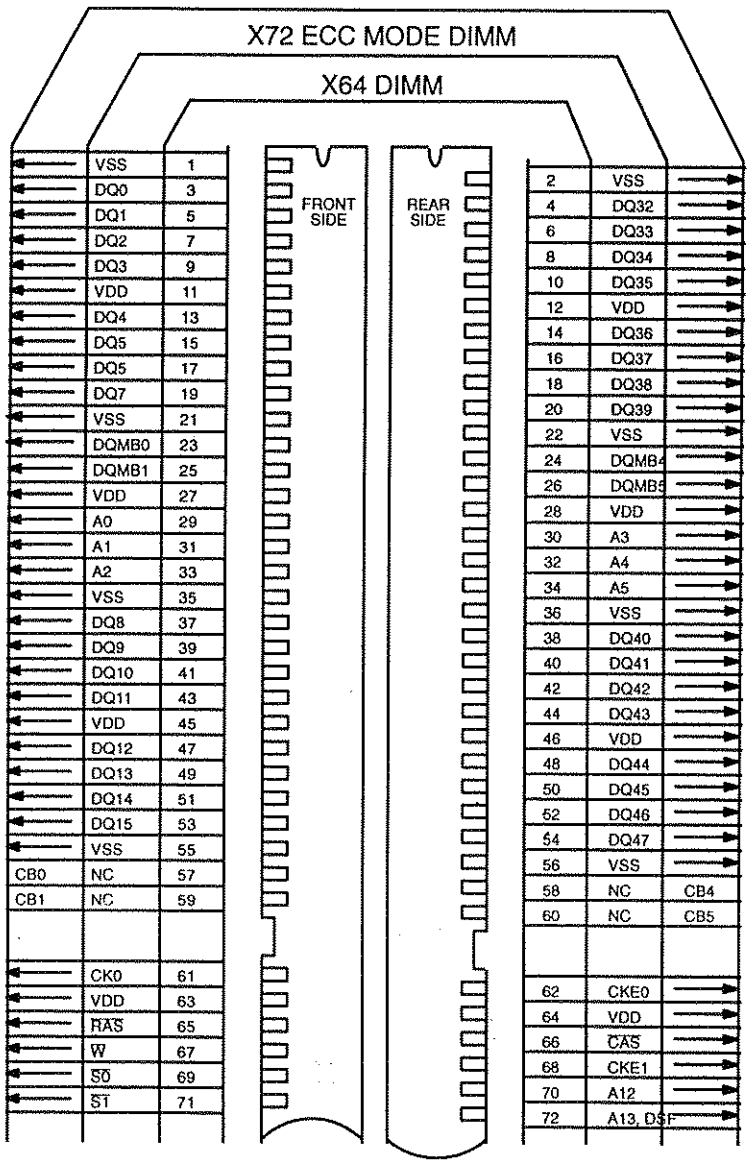



**Figure 4.5.6–A**
**144 Pin X64 & X72 SDRAM SO–DIMM, PIN ASSIGNMENTS**
**UPPER HALF**

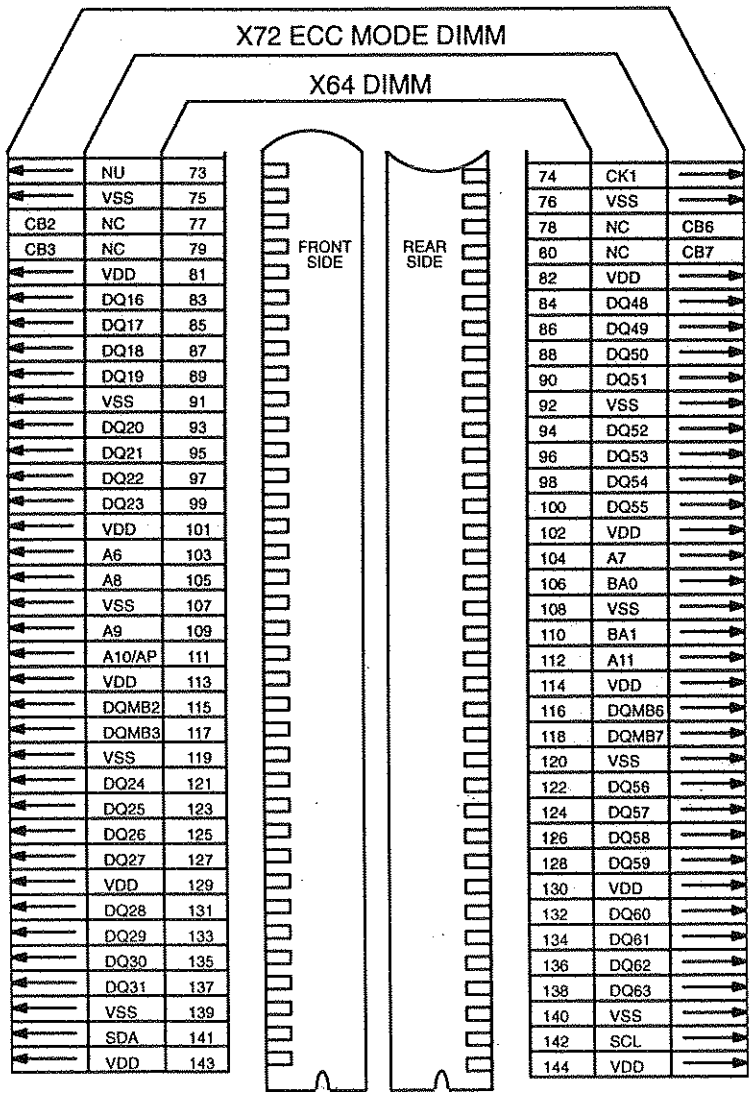



**Figure 4.5.6–B**
**144 Pin X64 & X72 SDRAM SO–DIMM, PIN ASSIGNMENTS**
**LOWER HALF**

360



| Module Configuration | SDRAM Organization | Option 1 | | | Option 2 | | | Option 3 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | # Bank accr. | $\overline{RAS}$ accr. | $\overline{CAS}$ accr. | # Bank accr. | $\overline{RAS}$ accr. | $\overline{CAS}$ accr. | # Bank accr. | $\overline{RAS}$ accr. | $\overline{CAS}$ accr. |
| 1M x 64/72 | 1M x 16 | 1 | 11 | 8 | | | | | | |
| 2M x 64/72 | 1M x 16 | 1 | 11 | 8 | | | | | | |
| 2M x 64 | 2M x 32 | 2 | 11 | 8 | | | | | | |
| 2M x 64/72 | 2M x 8 | 1 | 11 | 9 | | | | | | |
| 4M x 64/72 | 2M x 8 | 1 | 11 | 9 | | | | | | |
| 4M x 64 | 2M x 32 | 2 | 11 | 8 | | | | | | |
| 4M x 64/72 | 4M x 16 | 2 | 12 | 8 | 1 | 13 | 8 | | | |
| 8M x 64/72 | 4M x 16 | 2 | 12 | 8 | 1 | 13 | 8 | | | |
| 8M x 64 | 8M x 32 | 2 | 13 | 8 | 2 | 12 | 9 | | | |
| 8M x 64/72 | 8M x 8 | 2 | 12 | 9 | 1 | 13 | 9 | | | |
| 16M x 64/72 | 8M x 8 | 2 | 12 | 9 | 1 | 13 | 9 | | | |
| 16M x 64 | 8M x 32 | 2 | 13 | 8 | 2 | 12 | 9 | | | |
| 16M x 64/72 | 16M x 16 | 2 | 13 | 9 | | | | | | |
| 32M x 64/72 | 16M x 16 | 2 | 13 | 9 | | | | | | |
| 32M x 64/72 | 32M x 8 | 2 | 13 | 10 | | | | | | |
| 64M x 64/72 | 32M x 8 | 2 | 13 | 10 | | | | | | |
| (Note: All options possible with SDRAM standards are shown) | | | | | | | | | | |

b. Allowable configurations: (Byte 11)
   - x64 (Non-parity, Byte controls)
   - x72 (ECC-optimized, Byte controls)

c. Functional Attributes:
   - Power Supply Voltage/Interface levels (Byte 8)
   - SDRAM cycle time (Byte 9)
   - SDRAM access from Clock (Byte 10)
   - Refresh rate/type (Byte 12)
   - SDRAM module attributes (Byte 13)
   - SDRAM device attributes (Bytes 14 - 20)
   - Primary/Secondary SDRAM (Bytes 21 - 22)

## Figure 4.5.6–C
## 144 Pin SDRAM SO–DIMM, PD INFORMATION

The diagram below shows the keying methodology employed on 8-byte SO DIMMs. The voltage key provides a positive interlock so that SO DIMMs can only be plugged into a system with the proper supply voltage, reducing potential damage to the module DRAM chips. Unless the designer chooses the appropriate connector, the system will not work.

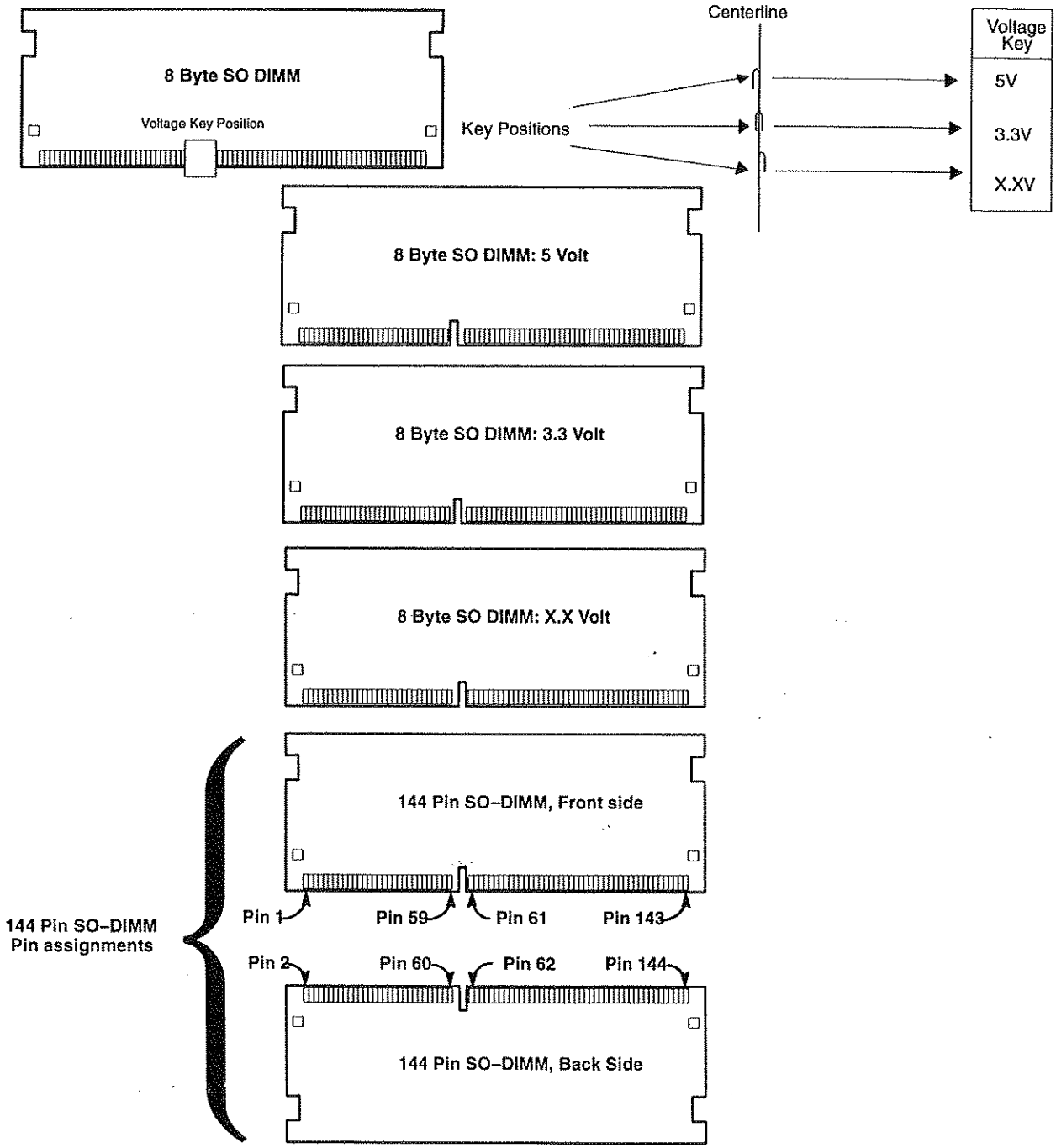



**Figure 4.5.6–D**
**144 Pin SDRAM DIMM Keying Methodology**

| Pin # | DRAM SODIMM | SDRAM SODIMM |
|---|---|---|
| 23 | $\overline{CAS0}$ | DQMB0 |
| 25 | $\overline{CAS1}$ | DQMB1 |
| | | |
| 61 | DU | CK0 |
| | | |
| 65 | DU | $\overline{RAS}$ |
| | | |
| 69 | $\overline{RAS0}$ | $\overline{S0}$ |
| 71 | $\overline{RAS1}$ | $\overline{S1}$ |
| 73 | $\overline{OE}$ | DU |
| | | |
| 111 | A10 | A10/AP |
| | | |
| 115 | $\overline{CAS2}$ | DQMB2 |
| 117 | $\overline{CAS3}$ | DQMB3 |
| | | |
| 24 | $\overline{CAS4}$ | DQMB4 |
| 26 | $\overline{CAS5}$ | DQMB5 |
| | | |
| 62 | DU | CKE0 |
| | | |
| 66 | DU | $\overline{CAS}$ |
| 68 | NC | CKE1 |
| 70 | NC | A12 |
| 72 | NC | A13, DSF |
| | | |
| 74 | NC | CK1 |
| | | |
| 106 | A11 | BA0 |
| | | |
| 110 | A12 | BA1 |
| 112 | A13 | A11 |
| | | |
| 116 | $\overline{CAS6}$ | DQMB6 |
| 118 | $\overline{CAS7}$ | DQMB7 |

**FIGURE 4.5.6–E**
**Pinout Comparison, 144 Pin DRAM & SDRAM SO–DIMM**

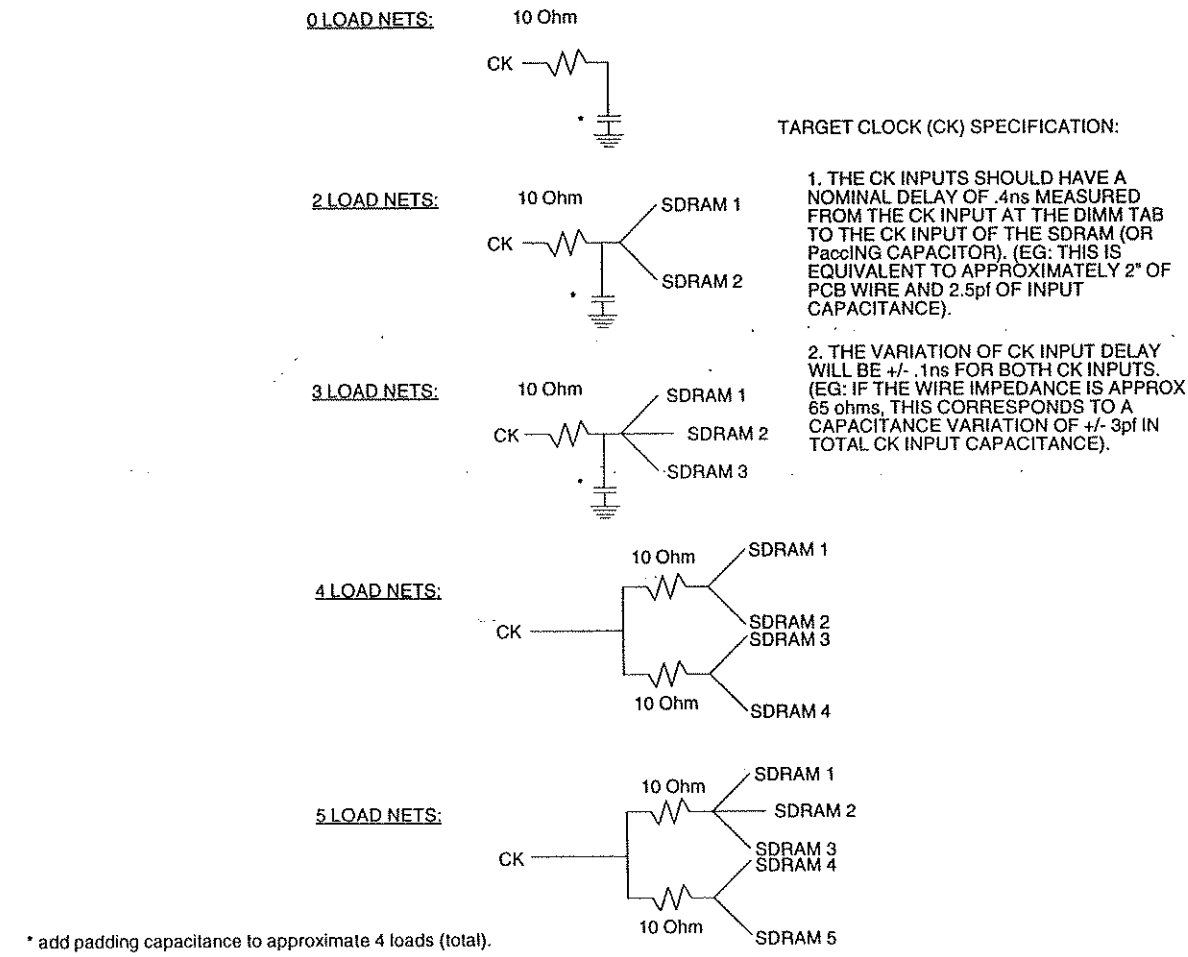


XILINX EXHIBIT 1012
Page 426

| Configuration | CK0 | CK1 |
|---|---|---|
| x8 (1 bank) | 4 | 4 |
| x16 (1 bank) | 4 | * |
| x8 (2 bank) | *1 (PLL) | * |
| x16 (2 bank) | 4 | 4 |

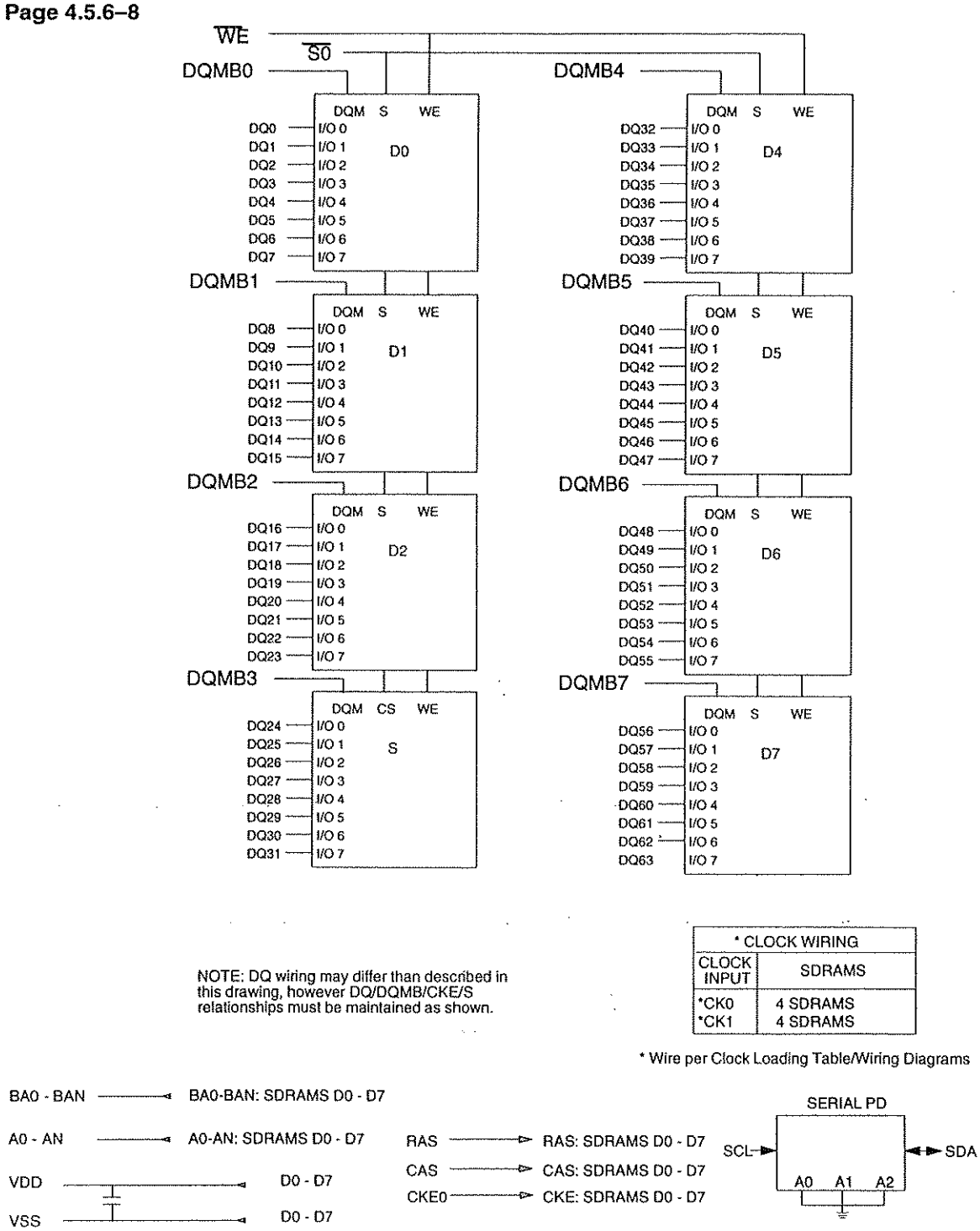
| Configuration | CK0 | CK1 |
|---|---|---|
| x8 (1 bank) | *4 OR 5 | *4 OR 5 |
| x16/x4 (1 bank) | *4 (MAX) | *4 (MAX) |
| x8 (2 bank) | *1 (PLL) | * |
| x16/x4 (2 bank) | *1 (PLL) | * |

- add padding capacitance per clock wiring diagram.




## Figure 4.5.6–F
## 144 Pin SDRAM SO–DIMM, CLOCK LOADING AND WIRING

**Release 7**

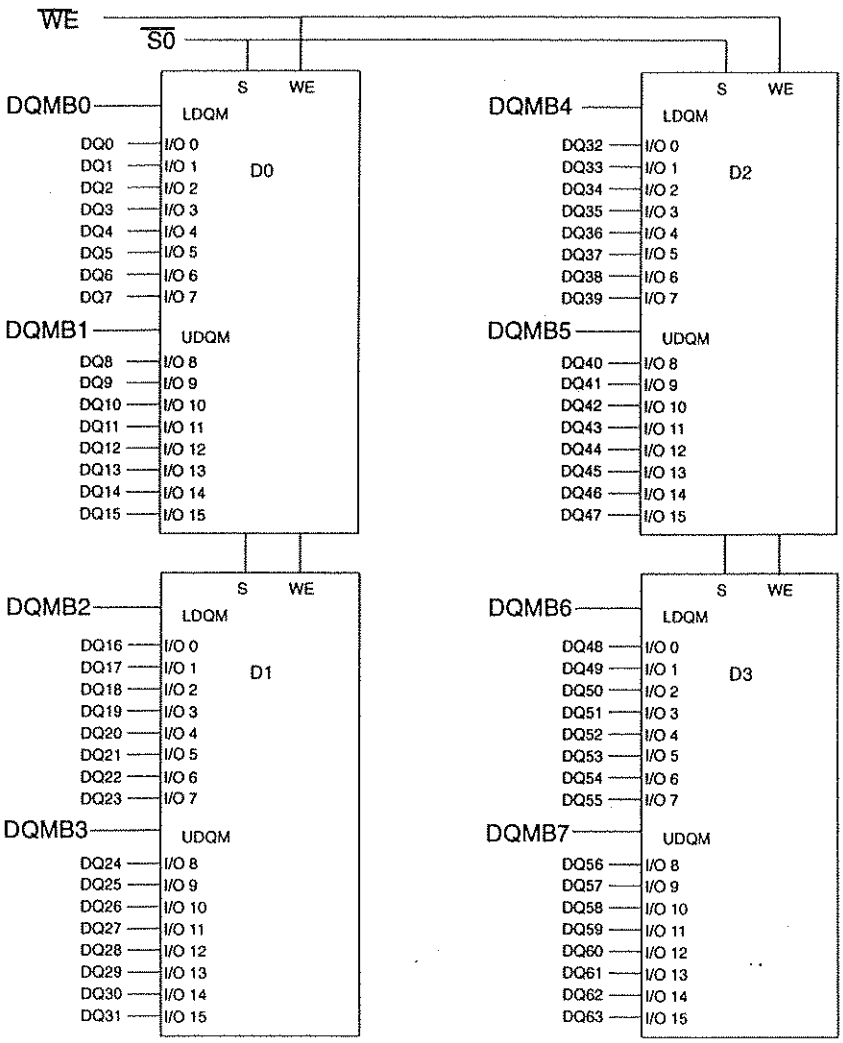



NOTE: DQ wiring may differ than described in this drawing, however DQ/DQMB/CKE/S relationships must be maintained as shown.

| * CLOCK WIRING | |
|---|---|
| CLOCK INPUT | SDRAMS |
| *CK0 | 4 SDRAMS |
| *CK1 | 4 SDRAMS |

* Wire per Clock Loading Table/Wiring Diagrams

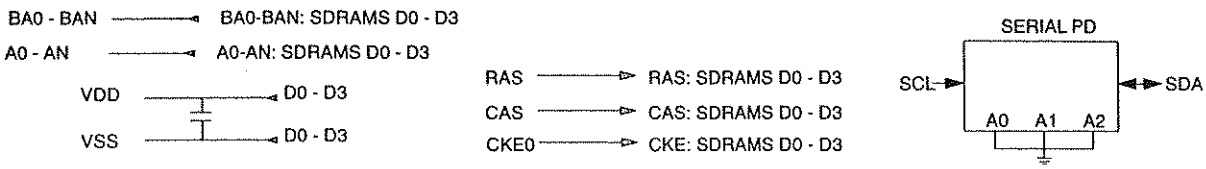
**Figure 4.5.6–G**
**144 Pin X64 SDRAM SO–DIMM, 1 Bank with X8 SDRAMs**



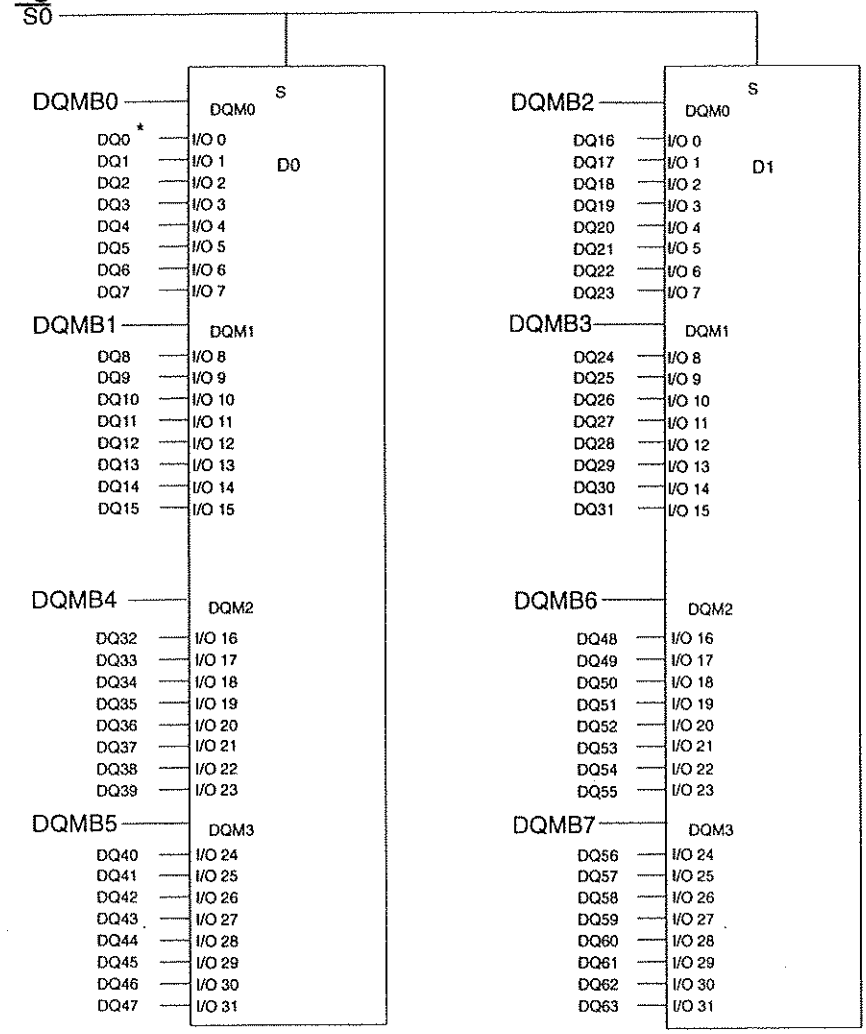

NOTE: DQ wiring may differ than described in this drawing, however DQ/DQMB/CKE/S relationships must be maintained as shown.

| * CLOCK WIRING | |
|---|---|
| CLOCK INPUT | SDRAMS |
| *CK0<br>*CK1 | 4 SDRAMS |

* Wire per Clock Loading Table/Wiring Diagrams

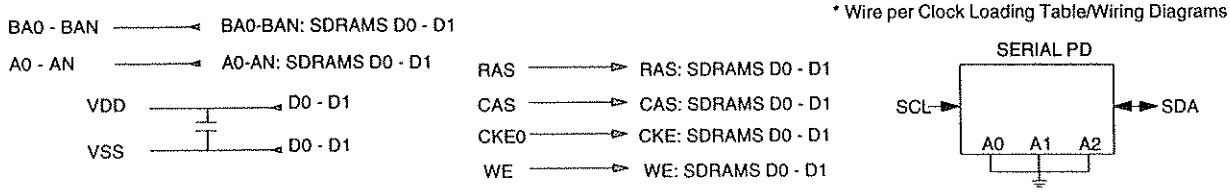



## Figure 4.5.6–H
## 144 Pin X64 SDRAM SO–DIMM, 1 Bank with X16 SDRAMs




NOTE: DQ wiring may differ than described in this drawing, however DQ/DQMB/CKE/S relationships must be maintained as shown.

| * CLOCK WIRING | |
|---|---|
| CLOCK INPUT | SDRAMS |
| *CK0<br>*CK1 | 2 SDRAMS |




## Figure 4.5.6–I
## 144 Pin X64 SDRAM SO–DIMM, 1 Bank with X32 SDRAMs

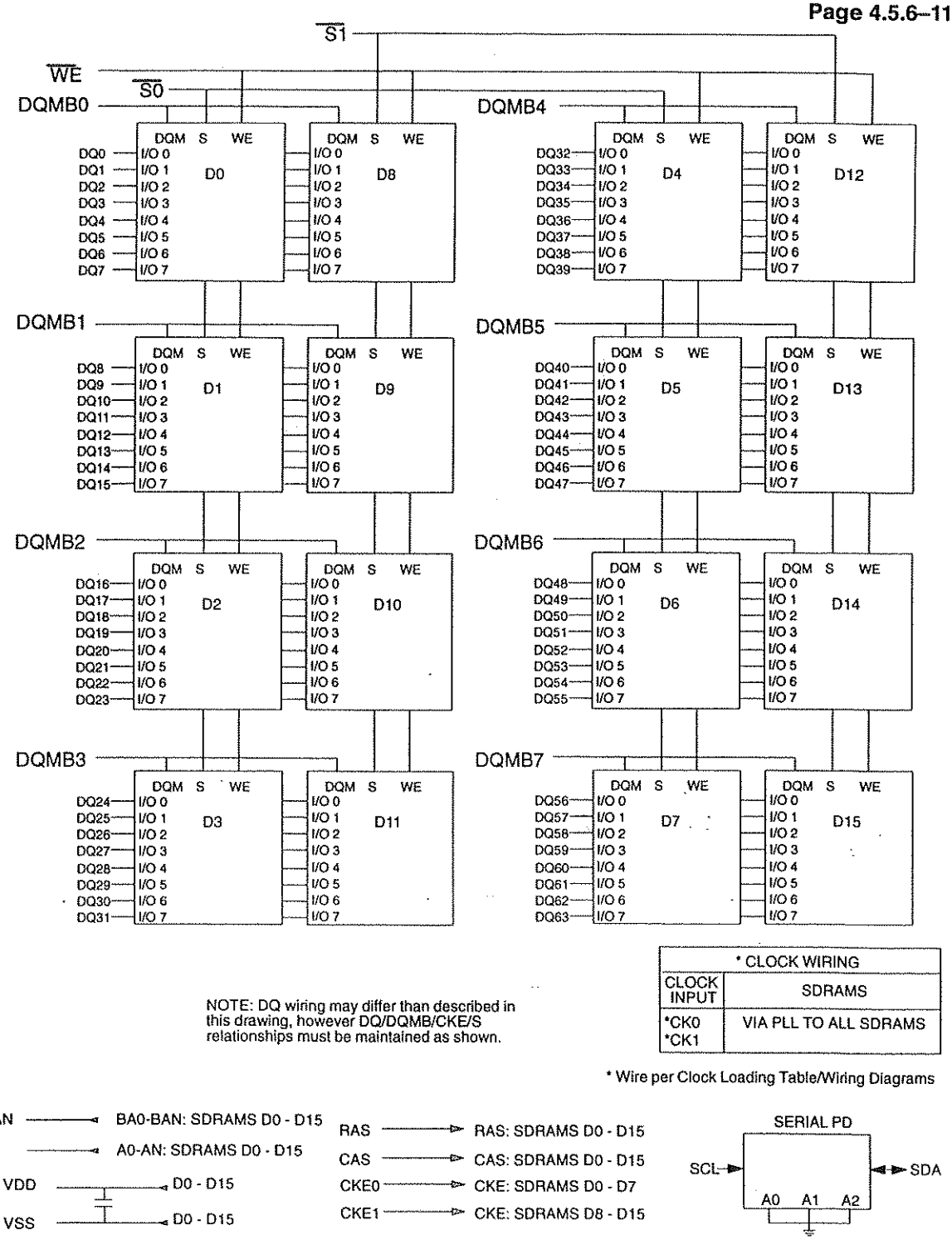
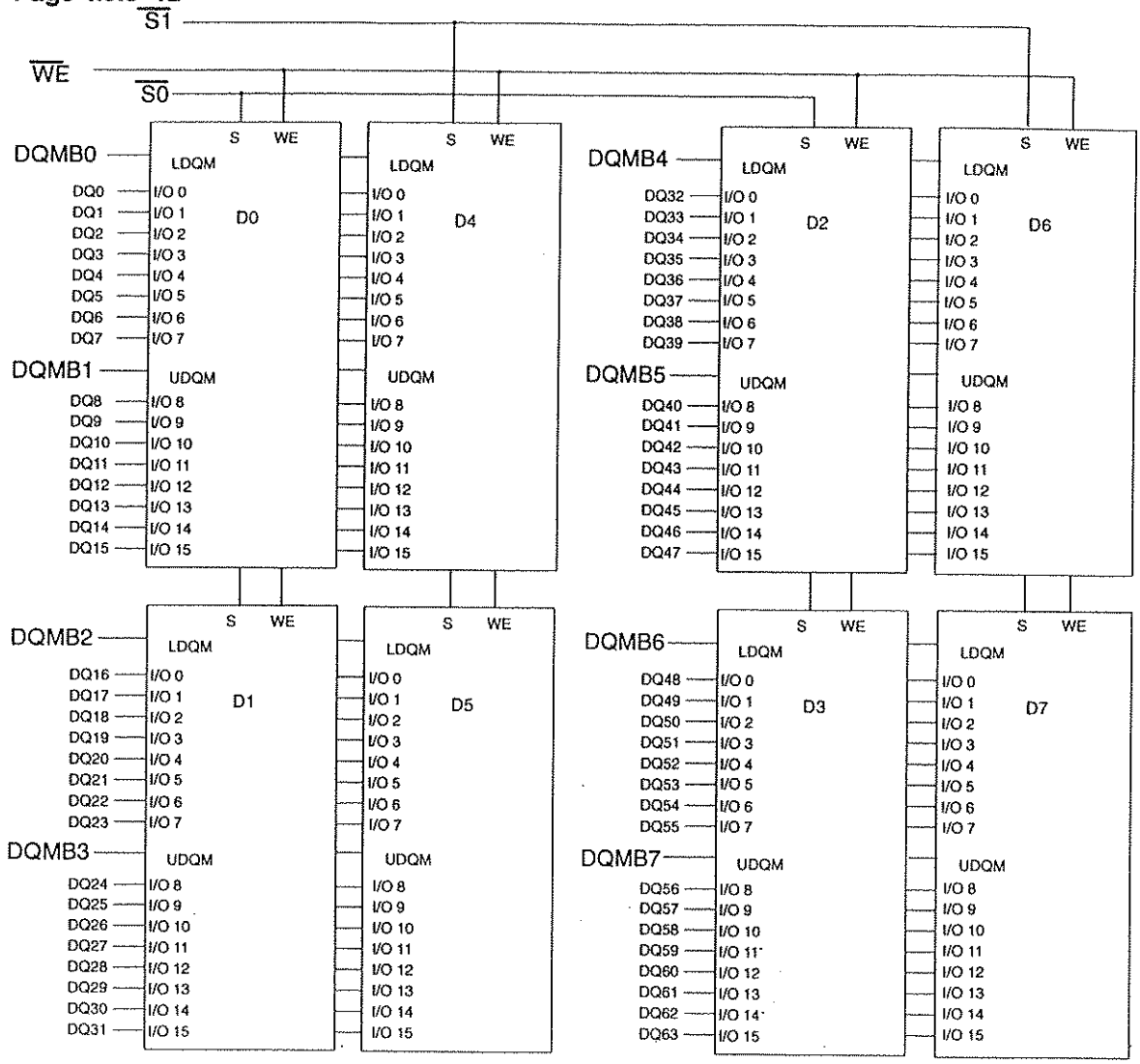


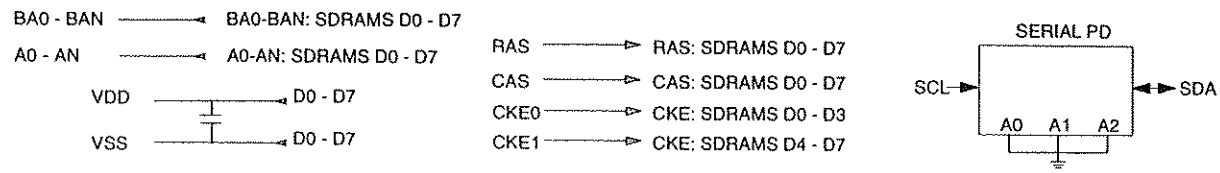

**Figure 4.5.6–J**
**144 Pin X64 SDRAM SO–DIMM, 2 Bank with X8 SDRAMs**



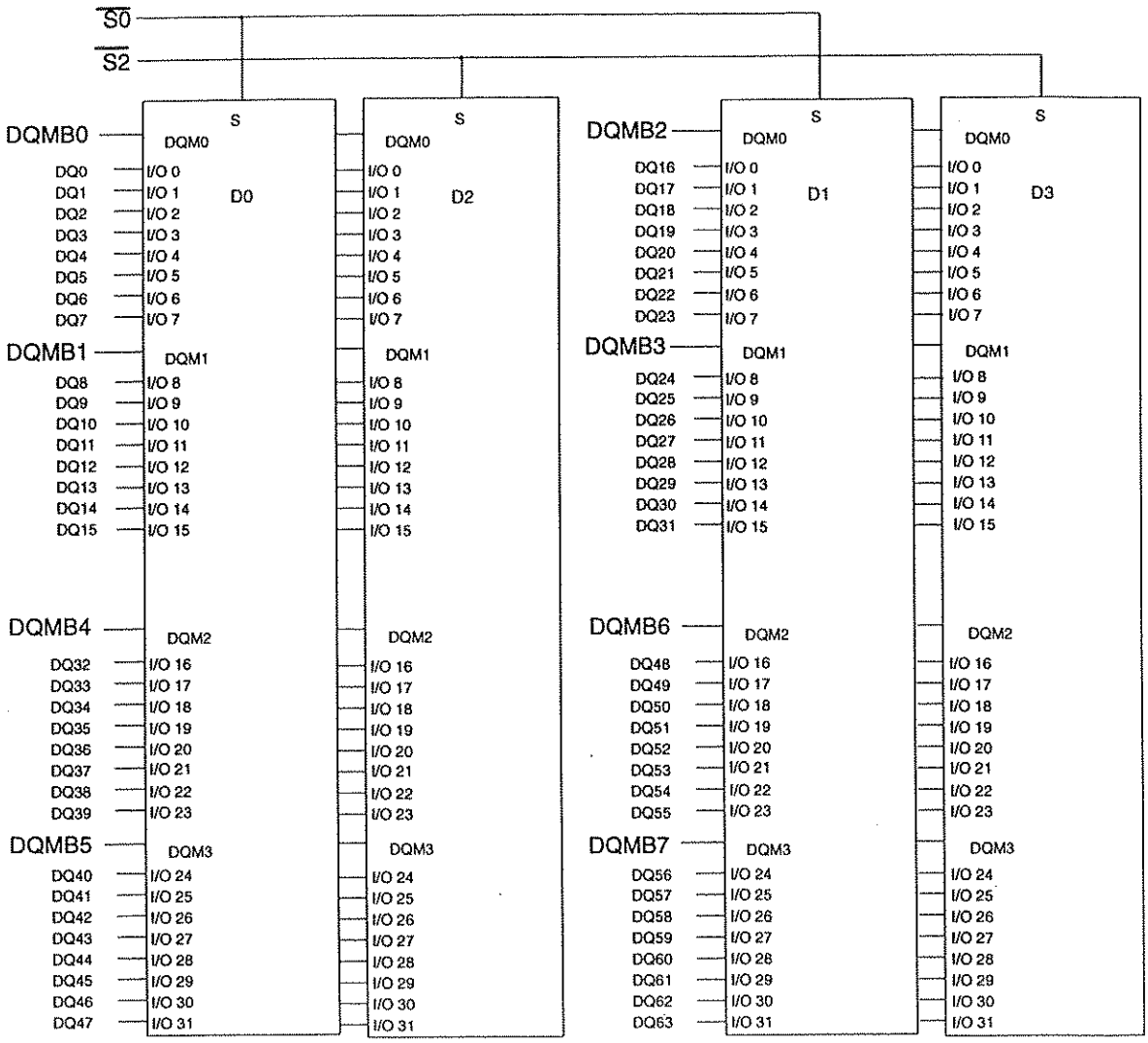

NOTE: DQ wiring may differ than described in this drawing, however DQ/DQMB/CKE/S relationships must be maintained as shown.

| * CLOCK WIRING | |
|---|---|
| CLOCK INPUT | SDRAMS |
| *CK0 | 4 SDRAMS |
| *CK1 | 4 SDRAMS |

* Wire per Clock Loading Table/Wiring Diagrams



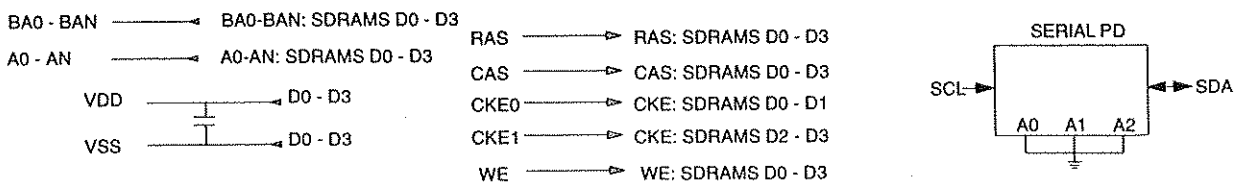

## Figure 4.5.6–K
## 144 Pin X64 SDRAM SO–DIMM, 2 Bank with X16 SDRAMs



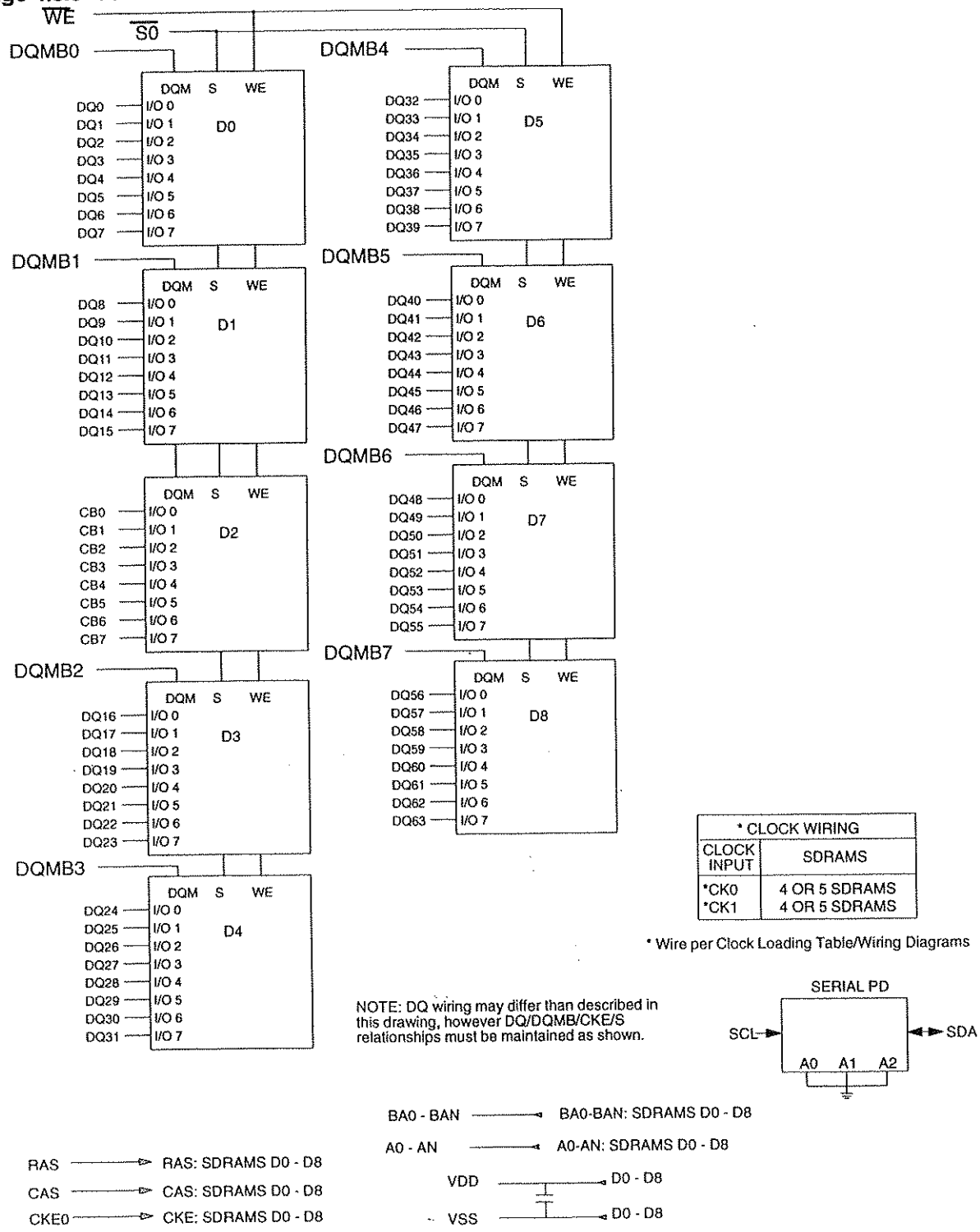

NOTE: DQ wiring may differ than described in this drawing, however DQ/DQMB/CKE/S relationships must be maintained as shown.

| * CLOCK WIRING | |
|---|---|
| CLOCK INPUT | SDRAMS |
| *CK0<br>*CK1 | 4 SDRAMS |

* Wire per Clock Loading Table/Wiring Diagrams




## Figure 4.5.6–L
## 144 Pin X64 SDRAM SO–DIMM, 2 Bank with X32 SDRAMs




| * CLOCK WIRING | |
|---|---|
| CLOCK INPUT | SDRAMS |
| *CK0 | 4 OR 5 SDRAMS |
| *CK1 | 4 OR 5 SDRAMS |

* Wire per Clock Loading Table/Wiring Diagrams

NOTE: DQ wiring may differ than described in this drawing, however DQ/DQMB/CKE/S relationships must be maintained as shown.




**Figure 4.5.6–M**
**144 Pin X72 ECC SDRAM SO–DIMM, 1 Bank with X8 SDRAMs**

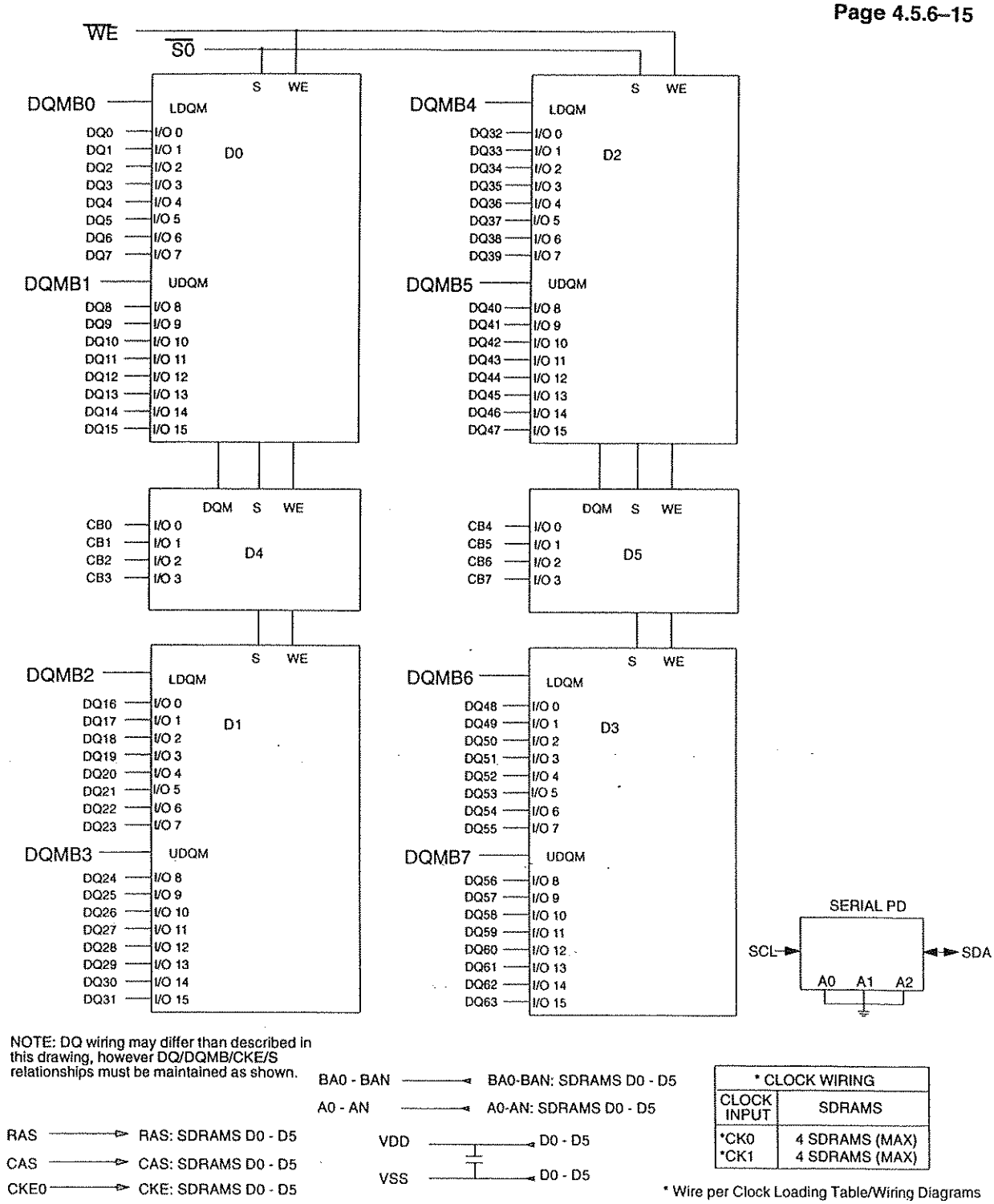



**Figure 4.5.6–N**
**144 Pin X72 ECC SDRAM SO–DIMM, 1 Bank with X16 & X4 SDRAMs**



XILINX EXHIBIT 1012
Page 435

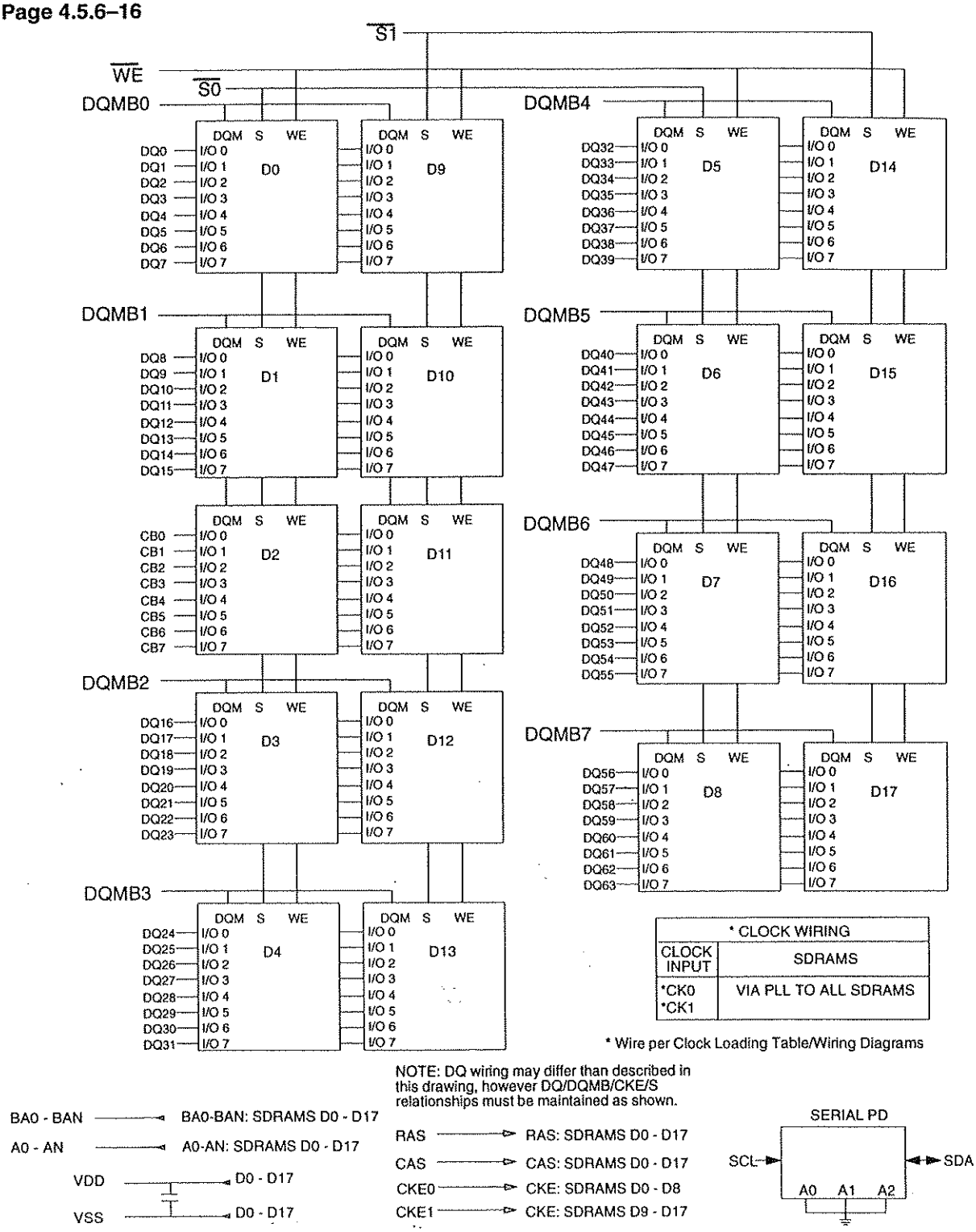



**Figure 4.5.6–O**
**144 Pin X72 ECC SDRAM SO–DIMM, 2 Bank with X8 SDRAMs**

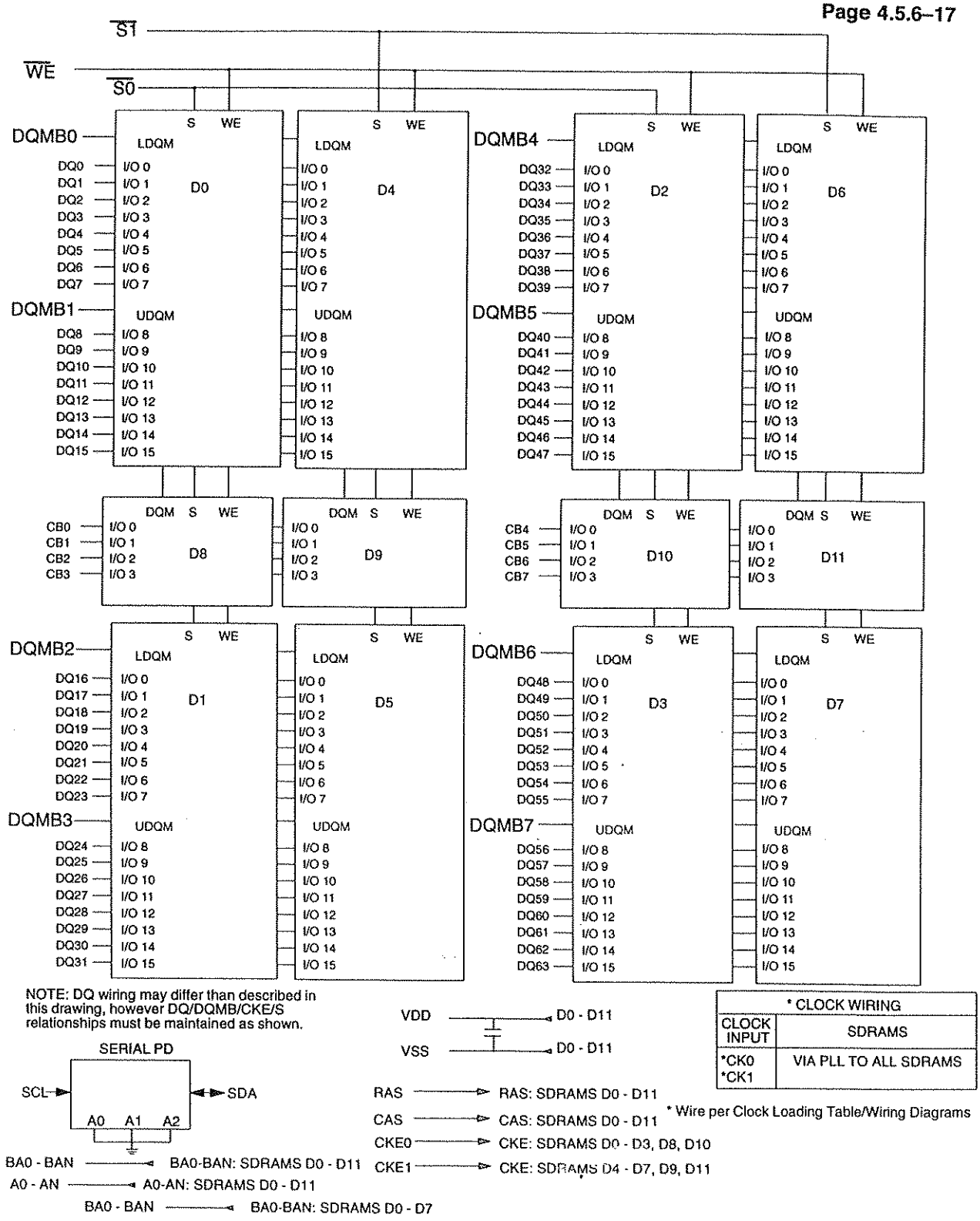



**Figure 4.5.6–P**
**144 Pin X72 ECC SDRAM SO–DIMM, 2 Bank with X16 & X4 DRAMs**

**Release 7**

# 4.6 Sixteen Byte Memory Modules

## 4.6.1 – 278 PIN BUFFERED SDRAM DIMM FAMILY



XILINX EXHIBIT 1012
Page 439

## 4.6.1 – 278 PIN BUFFERED SDRAM DIMM FAMILY

CAPACITY—up to the addressing capacity of 16 bits, address multiplexed with words of 16 bytes (144 bits).
DATA CONFIGURATIONS—Only one DATA Word configurations is defined in the initial release:
—144 BIT SDRAM with the location of CHECKBITS undefined
CONFIGURATION—2 Different Configurations are defined using X16 SDRAM memories with 1 and 2 banks
LOGIC FEATURES—The modules contain the Serial Presence Detect (SPD) feature that conist of a built in serial access EEPROM that stores information on mutiple parameters and attributes of the module such as technology, storage capacity, configuration, data word configuration, refresh mode, and speed of the module.
PACKAGE—278 PIN JEDEC DIMM MEMORY MODULE
PIN ASSIGNMENTS —Figs. 4.6.1–A, 4.6.1–B, & 4.6.1–C
DRAM SPD INFORMATOION — Fig. 4.6.1–D
MODULE KEYING DEFINITION — Fig. 4.6.1–E
MODULE PIN DEFINITIONS — Fig. 4.6.1–F
X144 SDRAM CONFIGURATION BLOCK DIAGRAMS —Figs. 4.6.1–G and 4.6.1–H

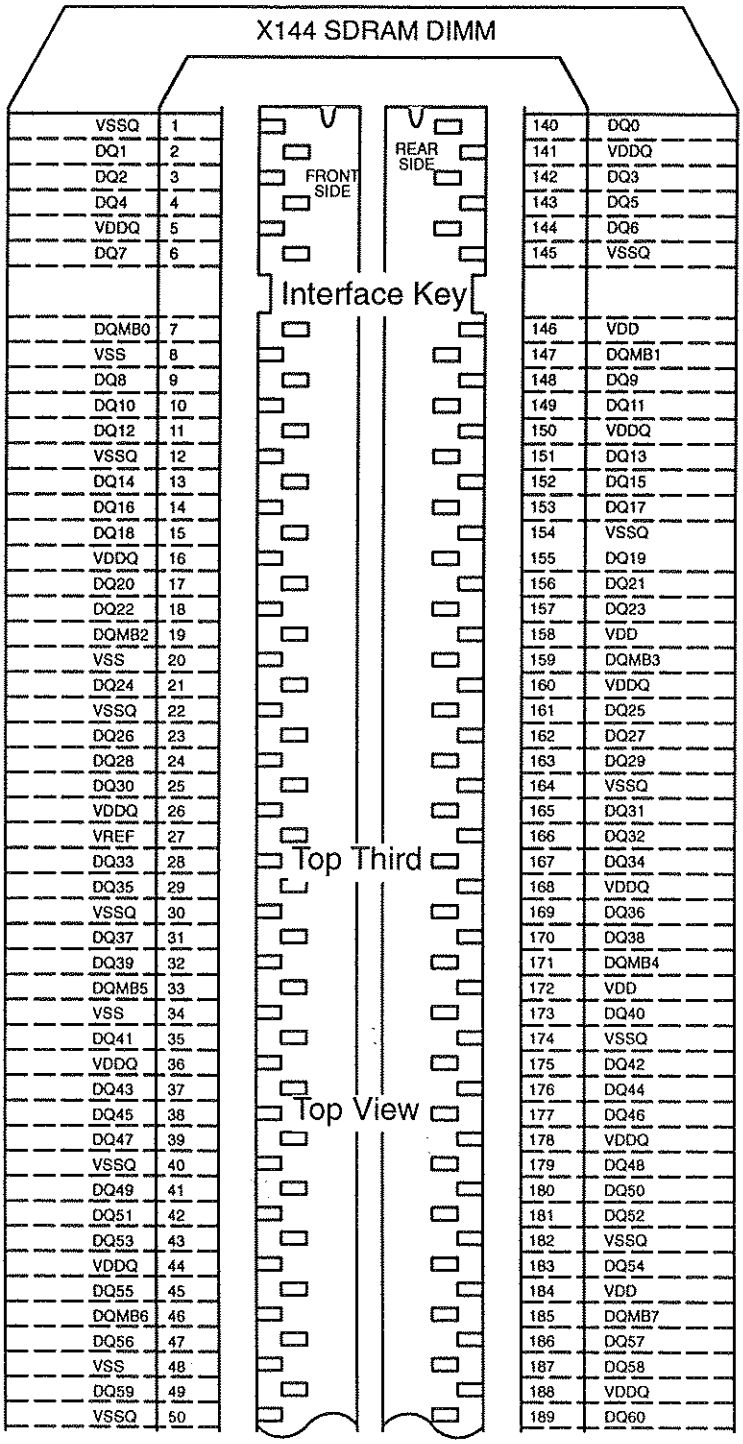



**Figure 4.6.1–A**
**278 PIN X144 SDRAM DIMM PINOUT (TOP THIRD)**

Release 7

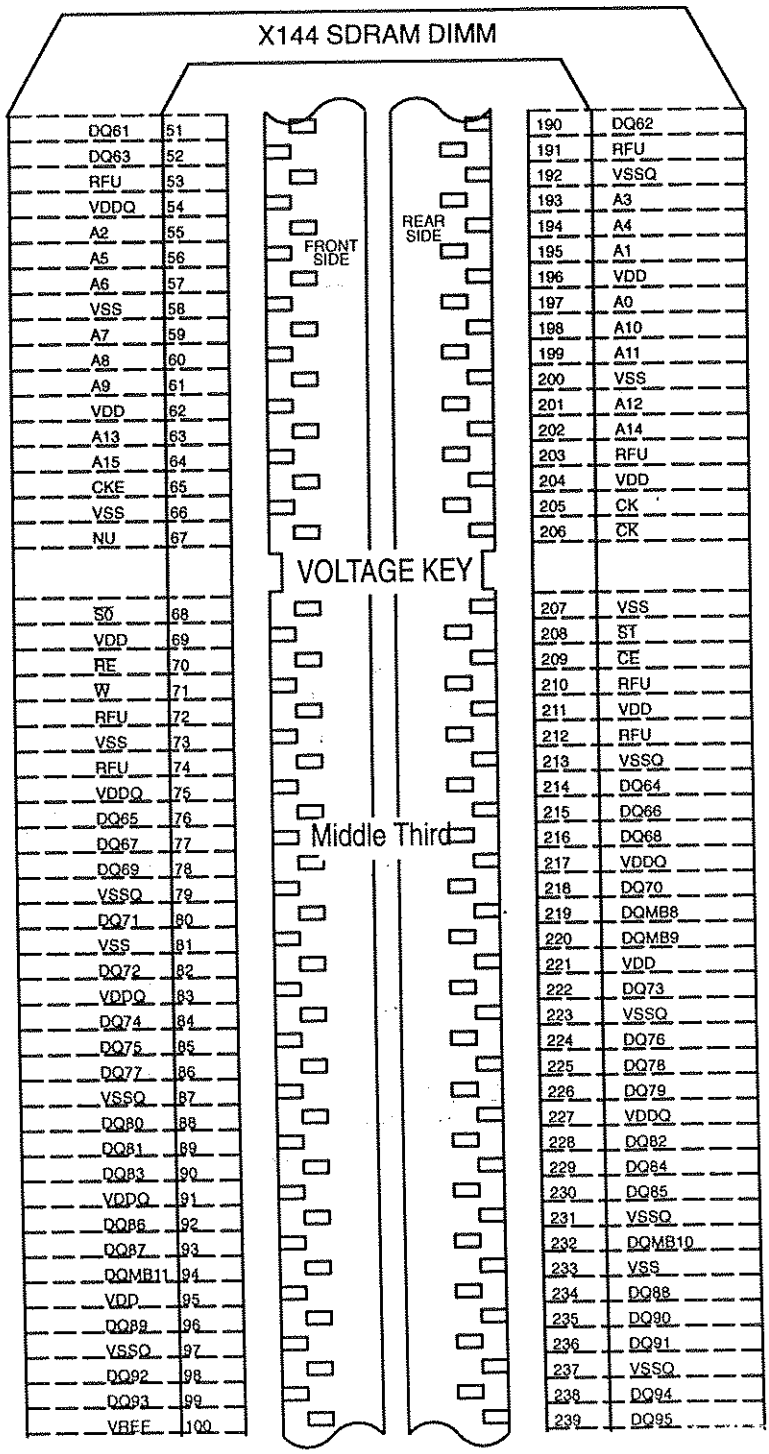



**Figure 4.6.1–B**
**278 PIN X144 SDRAM DIMM PINOUT (MIDDLE THIRD)**

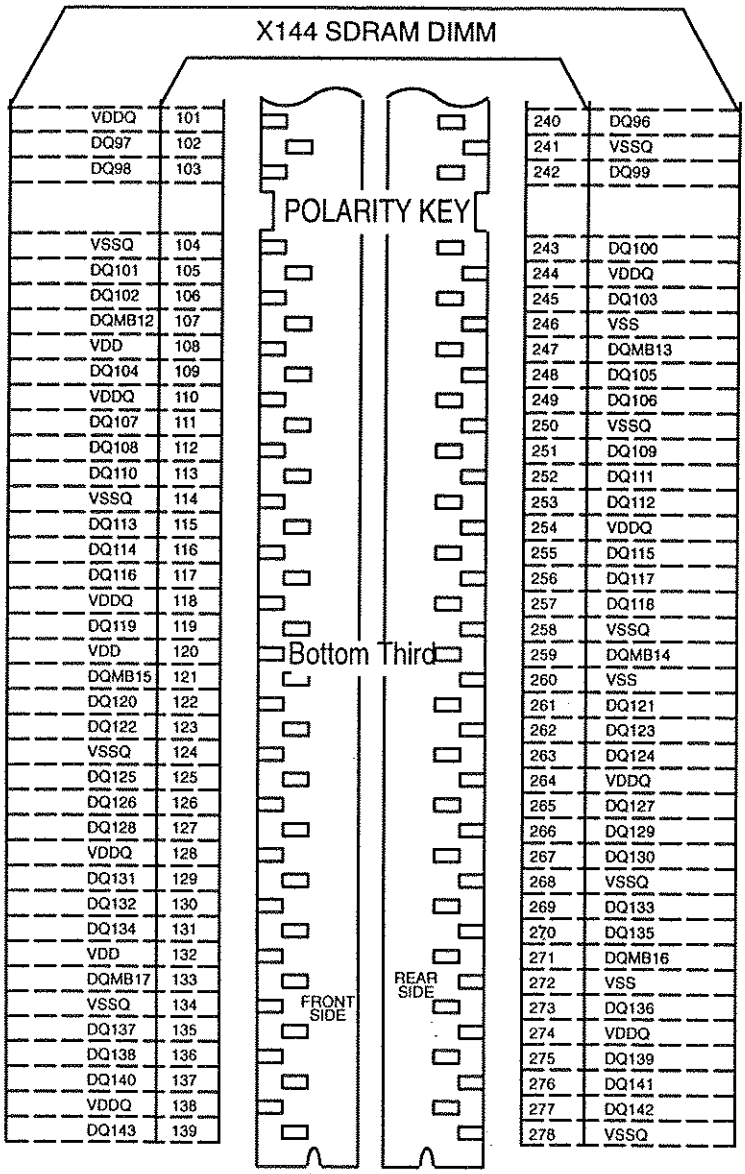



**Figure 4.6.1–C**
**278 PIN X144 SDRAM DIMM PINOUT (BOTTOM THIRD)**
**Release 7**

This page is reserved for the future addition of serial presence detect tables.

**Figure 4.6.1–D**
**278 PIN X144 SDRAM DIMM PD AND CONFIGURATION TABLES**
Release 7

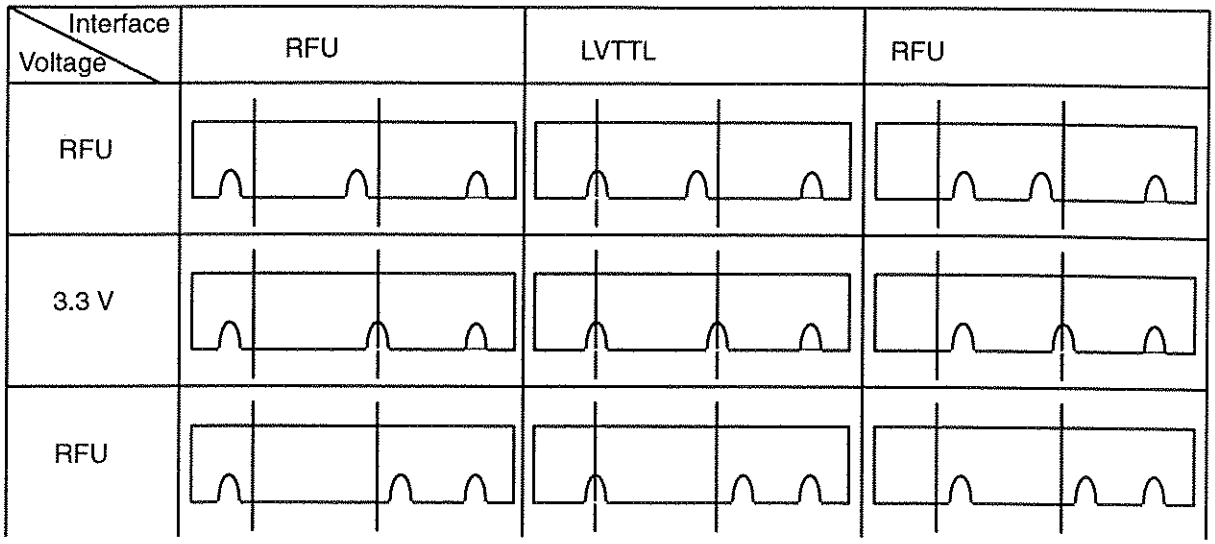
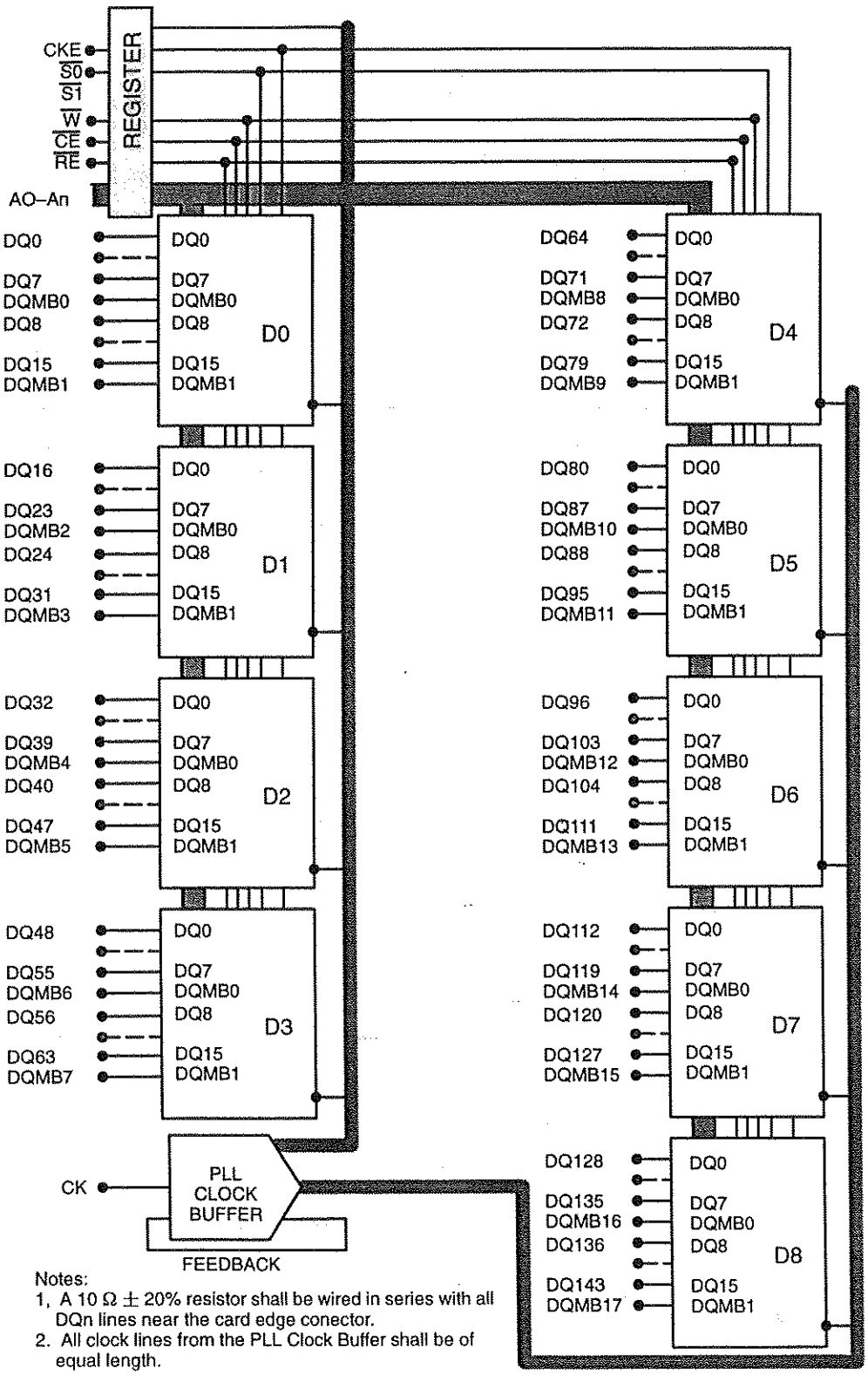



**Figure 4.6.1–E**
**278 PIN 144 BIT SDRAM DIMM MECHANICAL KEY DEFINITION**

| Pin Name | Number | Function |
|---|---|---|
| A0....A15 | 16 | Address Input (multiplexed) |
| DQ0....DQ143 | 144 | Data Input/Output (common) |
| CK, $\overline{CK}$ | 2 | Clock Input |
| CKE | 1 | Clock Enable Input |
| $\overline{S0}$, $\overline{S1}$ | 2 | Chip Select Input |
| $\overline{RE}$ | 1 | Row Enable (RAS) Input |
| $\overline{CE}$ | 1 | Column Enable (CAS) Input |
| $\overline{W}$ | 1 | Write Enable Input |
| DQM | 1 | Data Mask |
| DQMB0....DQMB17 | 18 | Byte Data Mask input |
| VDD | 14 | Primary Positive Power Supply |
| VDDQ | 27 | Posivite Power for Input/Output |
| VREF | 2 | Reference Power Supply |
| VSS | 14 | Ground |
| VSSQ | 27 | Ground for data Input/Output |
| NU | 1 | Reserved for board test of PLL |
| RFU | 7 | Reserved for Future Use |

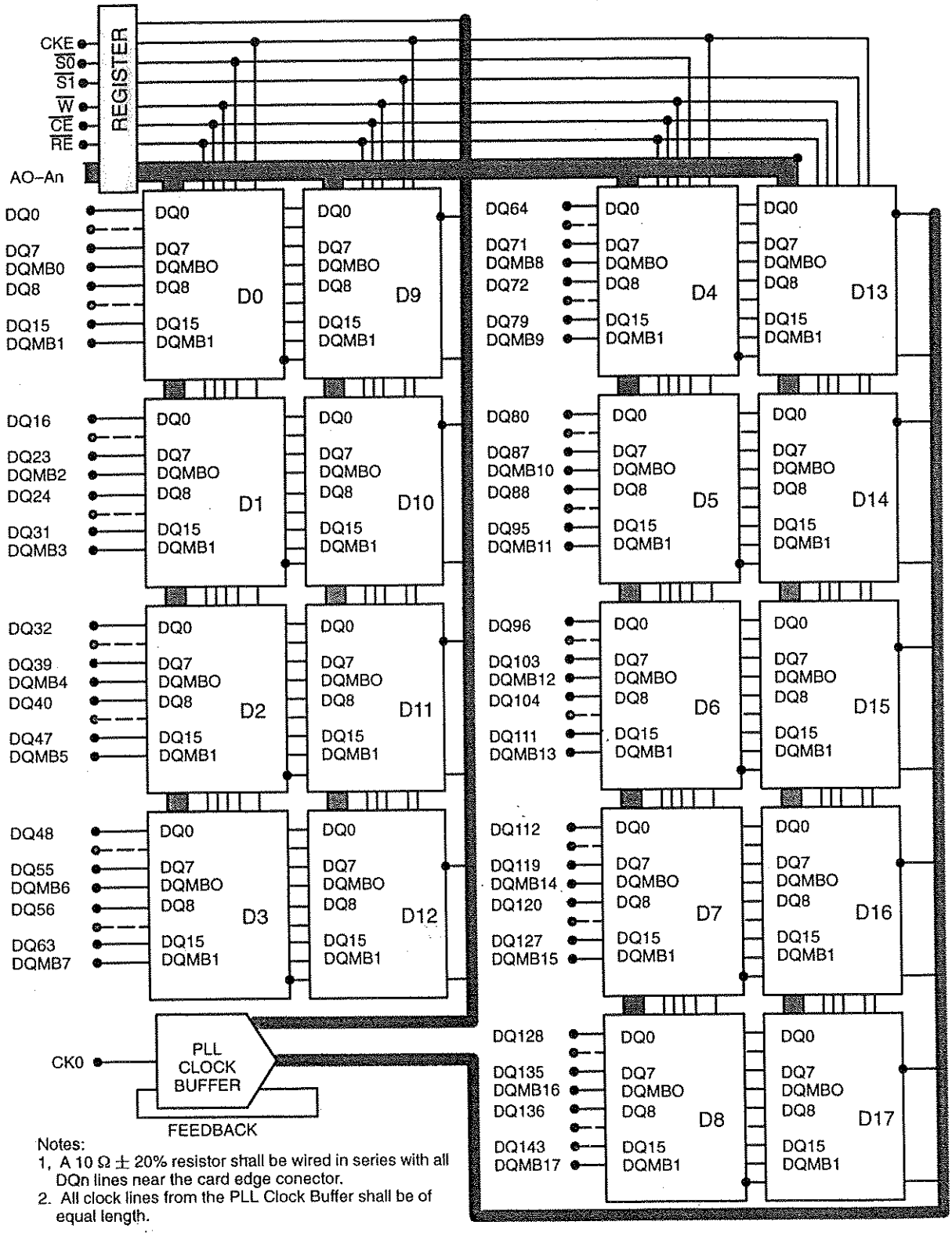
Notes:
1. NU pin is reserved for board test control of PLL, Make no connection at system level.
2 RFU pins are available for future standardization of serial Presence Detect and VTT.

**Figure 4.6.1–F**
**278 PIN 144 BIT SDRAM DIMM PIN DEFINITIONS**




Notes:
1, A 10 Ω ± 20% resistor shall be wired in series with all DQn lines near the card edge conector.
2. All clock lines from the PLL Clock Buffer shall be of equal length.

## Figure 4.6.1–G
## 278 PIN X144 BUFFERED SDRAM DIMM 1 BANK with X16 SDRAM
**Release 7**




Notes:
1. A 10 Ω ± 20% resistor shall be wired in series with all DQn lines near the card edge conector.
2. All clock lines from the PLL Clock Buffer shall be of equal length.

**Figure 4.6.1–H**
**278 PIN X144 BUFFERED SDRAM DIMM 2 BANKS with X16 SDRAM**
**Release 7**