



Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

With the principle of “Quality Parts,Customers Priority,Honest Operation,and Considerate Service”,our business mainly focus on the distribution of electronic components. Line cards we deal with include Microchip,ALPS,ROHM,Xilinx,Pulse,ON,Everlight and Freescale. Main products comprise IC,Modules,Potentiometer,IC Socket,Relay,Connector.Our parts cover such applications as commercial,industrial, and automotives areas.

We are looking forward to setting up business relationship with you and hope to provide you with the best service and solution. Let us make a better world for our industry!



## Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

Email & Skype: info@chipsmall.com Web: www.chipsmall.com

Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China



# IS42/45R86400D/16320D/32160D IS42/45S86400D/16320D/32160D



## 16Mx32, 32Mx16, 64Mx8 512Mb SDRAM

MAY 2015

### FEATURES

- Clock frequency: 200, 166, 143 MHz
- Fully synchronous; all signals referenced to a positive clock edge
- Internal bank for hiding row access/precharge
- Power supply:  $V_{DD}/V_{DDQ} = 2.3V-3.6V$   
IS42/45SxxxxD -  $V_{DD}/V_{DDQ} = 3.3V$   
IS42/45RxxxxD -  $V_{DD}/V_{DDQ} = 2.5$
- LVTTTL interface
- Programmable burst length  
– (1, 2, 4, 8, full page)
- Programmable burst sequence:  
Sequential/Interleave
- Auto Refresh (CBR)
- Self Refresh
- 8K refresh cycles every 64 ms
- Random column address every clock cycle
- Programmable  $\overline{CAS}$  latency (2, 3 clocks)
- Burst read/write and burst read/single write operations capability
- Burst termination by burst stop and precharge command
- Packages:  
x8/x16: 54-pin TSOP-II, 54-ball TF-BGA (x16 only)  
x32: 90-ball TF-BGA
- Temperature Range:  
Commercial (0°C to +70°C)  
Industrial (-40°C to +85°C)  
Automotive, A1 (-40°C to +85°C)  
Automotive, A2 (-40°C to +105°C)

### DEVICE OVERVIEW

ISSI's 512Mb Synchronous DRAM achieves high-speed data transfer using pipeline architecture. All inputs and outputs signals refer to the rising edge of the clock input. The 512Mb SDRAM is organized as follows.

### PACKAGE INFORMATION

IS42/45S32160D	IS42/45S16320D	IS42/45S86400D
IS42/45R32160D	IS42/45R16320D	IS42/45R86400D
4M x 32 x 4 banks	8M x 16 x 4 banks	16M x 8 x 4 banks
90-ball TF-BGA	54-pin TSOP-II 54-ball TF-BGA	54-pin TSOP-II

### KEY TIMING PARAMETERS

Parameter	-5	-6	-7	Unit
Clk Cycle Time				
$\overline{CAS}$ Latency = 3	5	6	7	ns
$\overline{CAS}$ Latency = 2	10	10	7.5	ns
Clk Frequency				
$\overline{CAS}$ Latency = 3	200	167	143	Mhz
$\overline{CAS}$ Latency = 2	100	100	133	Mhz
Access Time from Clock				
$\overline{CAS}$ Latency = 3	5.0	5.4	5.4	ns
$\overline{CAS}$ Latency = 2	6	6	5.4	ns

### ADDRESS TABLE

Parameter	16M x 32	32M x 16	64M x 8
Configuration	4M x 32 x 4 banks	8M x 16 x 4 banks	16M x 8 x 4 banks
Bank Address Pins	BA0, BA1	BA0, BA1	BA0, BA1
Autoprecharge Pins	A10/AP	A10/AP	A10/AP
Row Address	8K(A0 – A12)	8K(A0 – A12)	8K(A0 – A12)
Column Address	512(A0 – A8)	1K(A0 – A9)	2K(A0 – A9, A11)
Refresh Count			
Com./Ind./A1	8K / 64ms	8K / 64ms	8K / 64ms
A2	8K / 16ms	8K / 16ms	8K / 16ms

Copyright © 2015 Integrated Silicon Solution, Inc. All rights reserved. ISSI reserves the right to make changes to this specification and its products at any time without notice. ISSI assumes no liability arising out of the application or use of any information, products or services described herein. Customers are advised to obtain the latest version of this device specification before relying on any published information and before placing orders for products.

Integrated Silicon Solution, Inc. does not recommend the use of any of its products in life support applications where the failure or malfunction of the product can reasonably be expected to cause failure of the life support system or to significantly affect its safety or effectiveness. Products are not authorized for use in such applications unless Integrated Silicon Solution, Inc. receives written assurance to its satisfaction, that:

- a.) the risk of injury or damage has been minimized;
- b.) the user assume all such risks; and
- c.) potential liability of Integrated Silicon Solution, Inc is adequately protected under the circumstances

**DEVICE OVERVIEW**

The 512Mb SDRAM is a high speed CMOS, dynamic random-access memory designed to operate in either 3.3V V<sub>DD</sub>/V<sub>DDQ</sub> or 2.5V V<sub>DD</sub>/V<sub>DDQ</sub> memory systems, depending on the DRAM option. Internally configured as a quad-bank DRAM with a synchronous interface.

The 512Mb SDRAM (536,870,912 bits) includes an AUTO REFRESH MODE, and a power-saving, power-down mode. All signals are registered on the positive edge of the clock signal, CLK. All inputs and outputs are LVTTTL compatible.

The 512Mb SDRAM has the ability to synchronously burst data at a high data rate with automatic column-address generation, the ability to interleave between internal banks to hide precharge time and the capability to randomly change column addresses on each clock cycle during burst access.

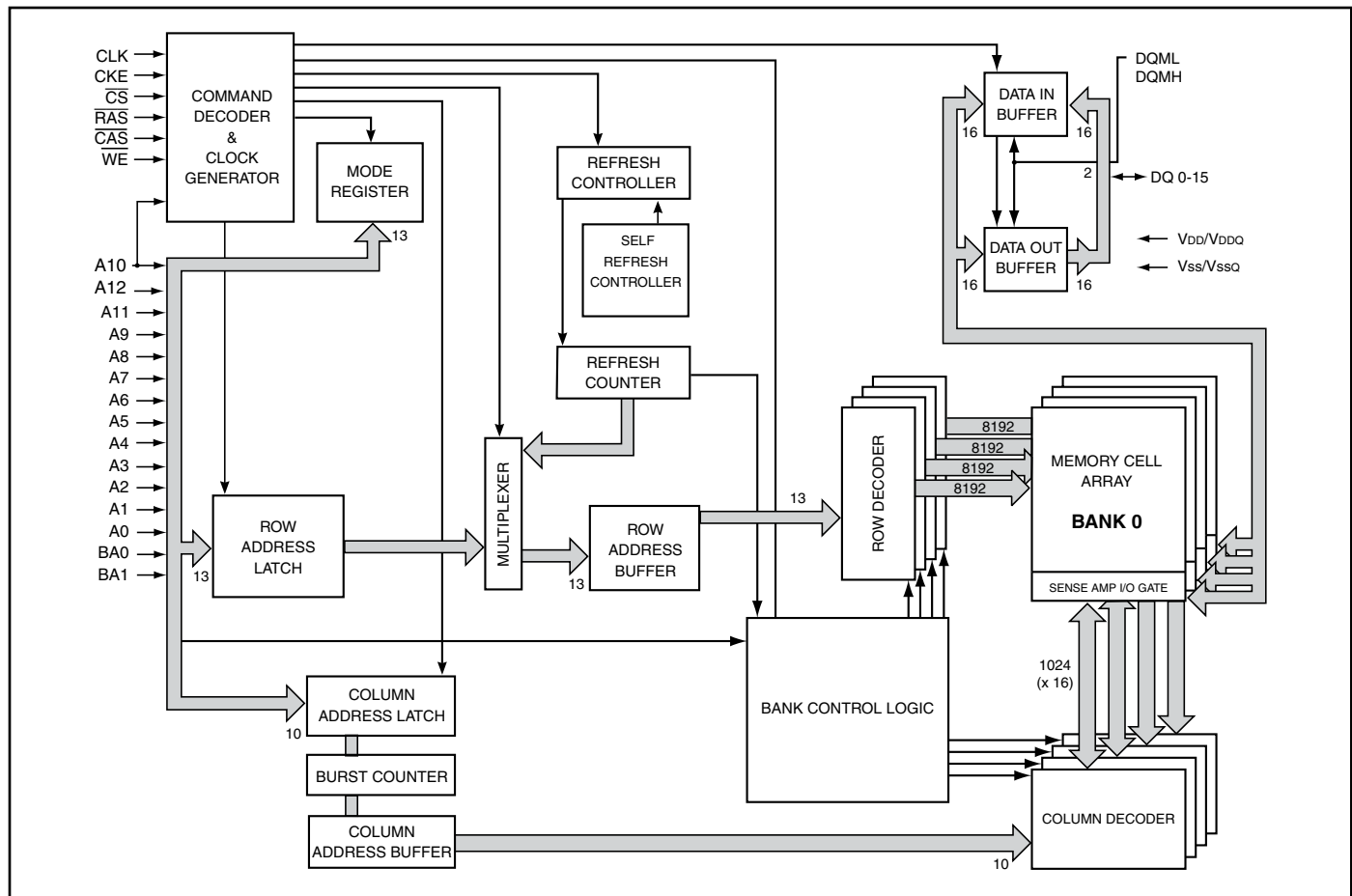
A self-timed row precharge initiated at the end of the burst

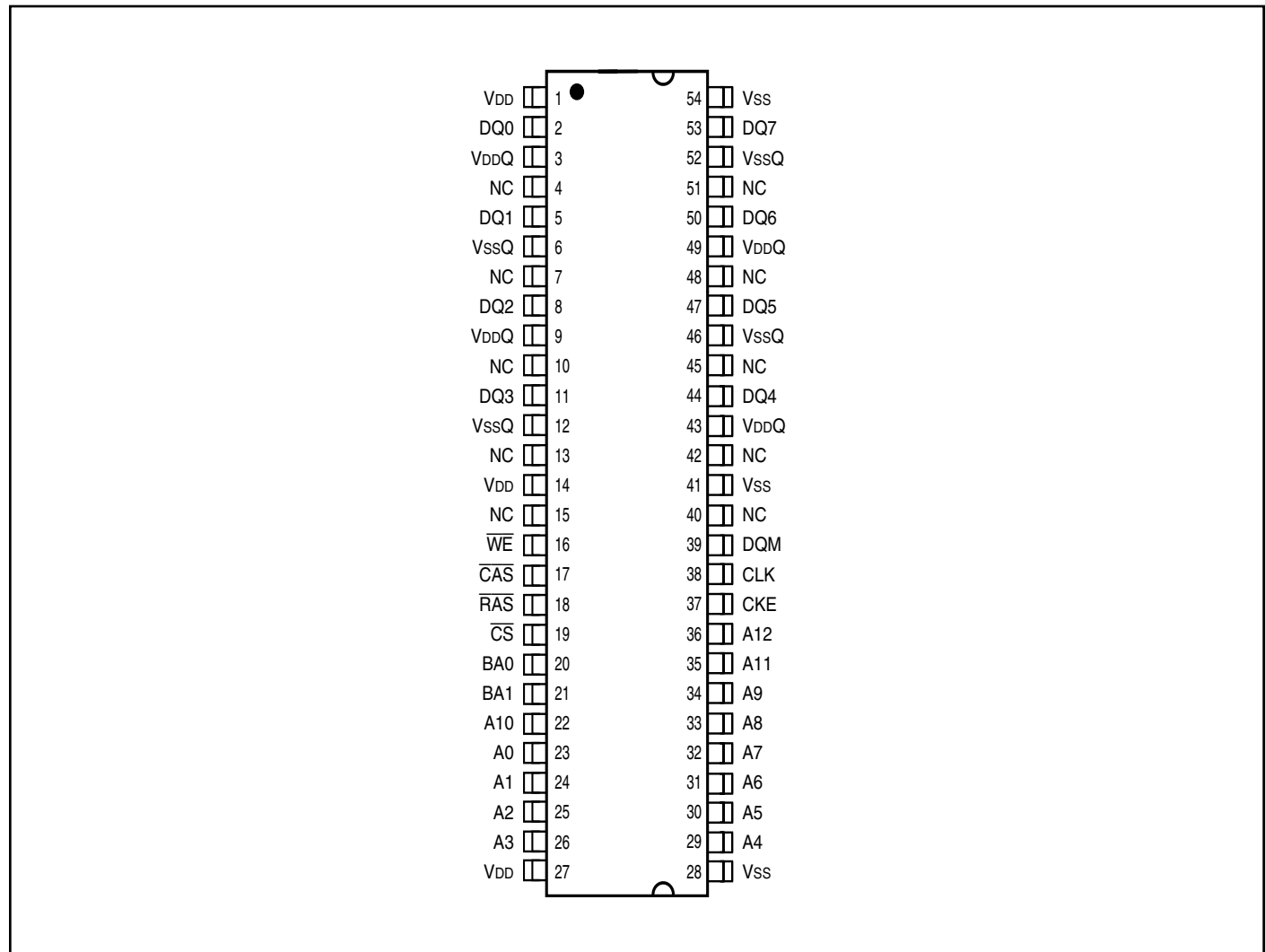
sequence is available with the AUTO PRECHARGE function enabled. Precharge one bank while accessing one of the other three banks will hide the precharge cycles and provide seamless, high-speed, random-access operation.

SDRAM read and write accesses are burst oriented starting at a selected location and continuing for a programmed number of locations in a programmed sequence. The registration of an ACTIVE command begins accesses, followed by a READ or WRITE command. The ACTIVE command in conjunction with address bits registered are used to select the bank and row to be accessed (BA0, BA1 select the bank; A0-A12 select the row). The READ or WRITE commands in conjunction with address bits registered are used to select the starting column location for the burst access.

Programmable READ or WRITE burst lengths consist of 1, 2, 4 and 8 locations or full page, with a burst terminate option.

**FUNCTIONAL BLOCK DIAGRAM (FOR 8MX16X4 BANKS SHOWN)**



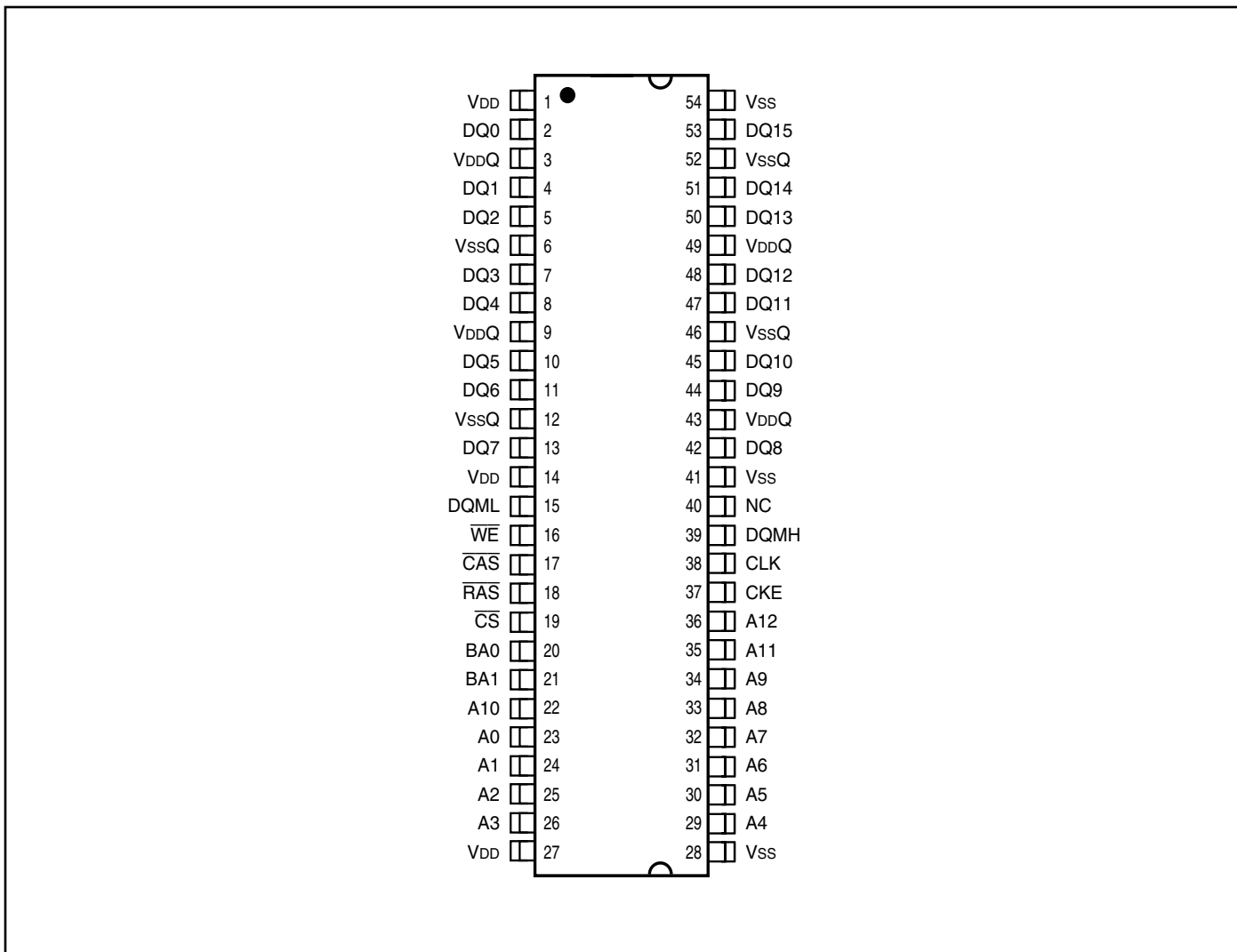
**PIN CONFIGURATIONS**
**54 pin TSOP - Type II for x8**

**PIN DESCRIPTIONS**

A0-A12	Row Address Input
A0-A9, A11	Column Address Input
BA0, BA1	Bank Select Address
DQ0 to DQ7	Data I/O
CLK	System Clock Input
CKE	Clock Enable
CS	Chip Select
RAS	Row Address Strobe Command
CAS	Column Address Strobe Command

WE	Write Enable
DQM	Data Input/Output Mask
VDD	Power
Vss	Ground
VDDQ	Power Supply for I/O Pin
VssQ	Ground for I/O Pin
NC	No Connection

### PIN CONFIGURATIONS

54 pin TSOP - Type II for x16



### PIN DESCRIPTIONS

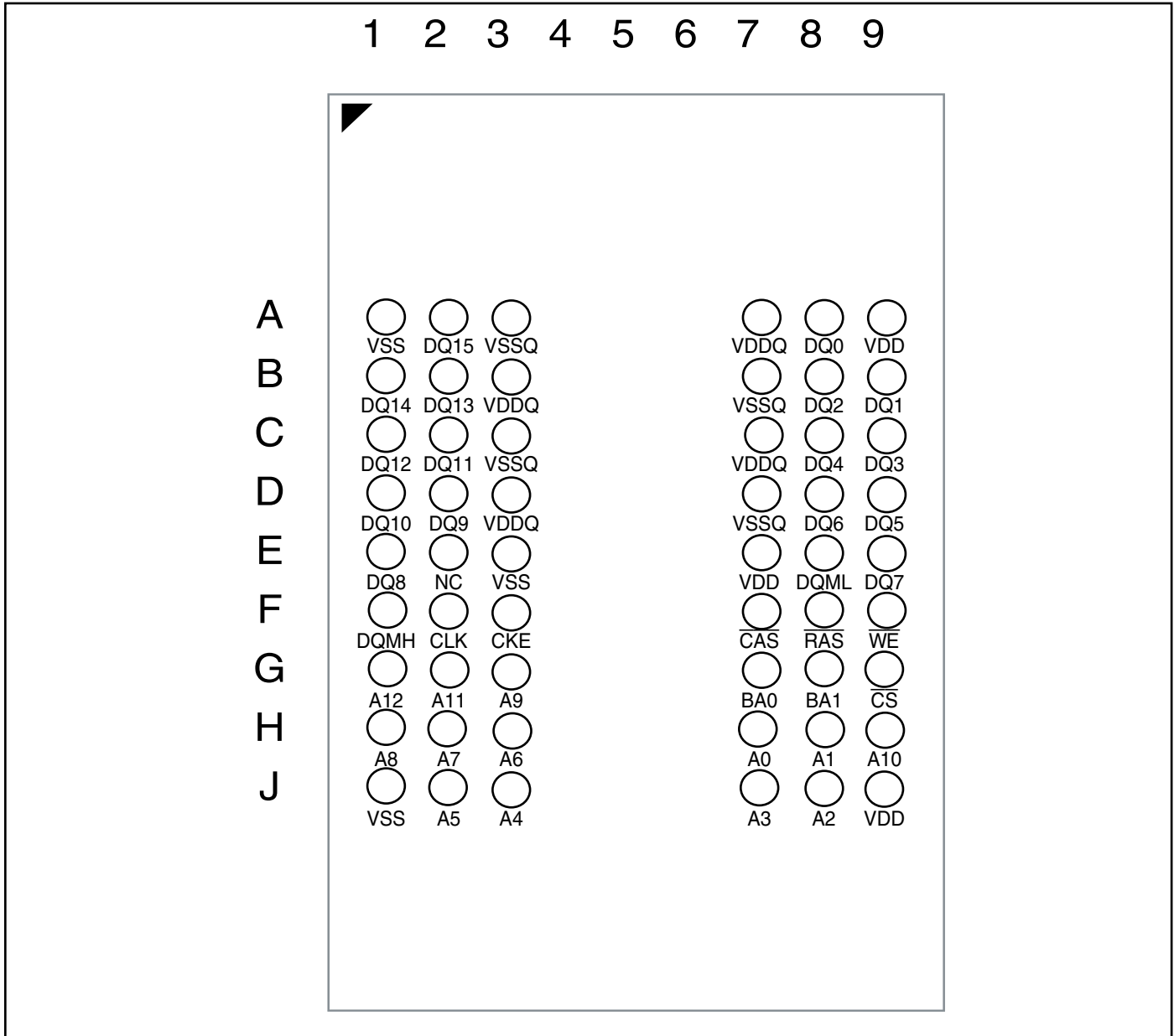
A0-A12	Row Address Input
A0-A9	Column Address Input
BA0, BA1	Bank Select Address
DQ0 to DQ15	Data I/O
CLK	System Clock Input
CKE	Clock Enable
CS	Chip Select
RAS	Row Address Strobe Command
CAS	Column Address Strobe Command

WE	Write Enable
DQML	x16 Lower Byte, Input/Output Mask
DQMH	x16 Upper Byte, Input/Output Mask
VDD	Power
Vss	Ground
VDDQ	Power Supply for I/O Pin
VSSQ	Ground for I/O Pin
NC	No Connection

# IS42/45R86400D/16320D/32160D, IS42/45S86400D/16320D/32160D

## PIN CONFIGURATION

54-ball TF-BGA for x16 (Top View) (8.00 mm x 13.00 mm Body, 0.8 mm Ball Pitch)  
package code: B



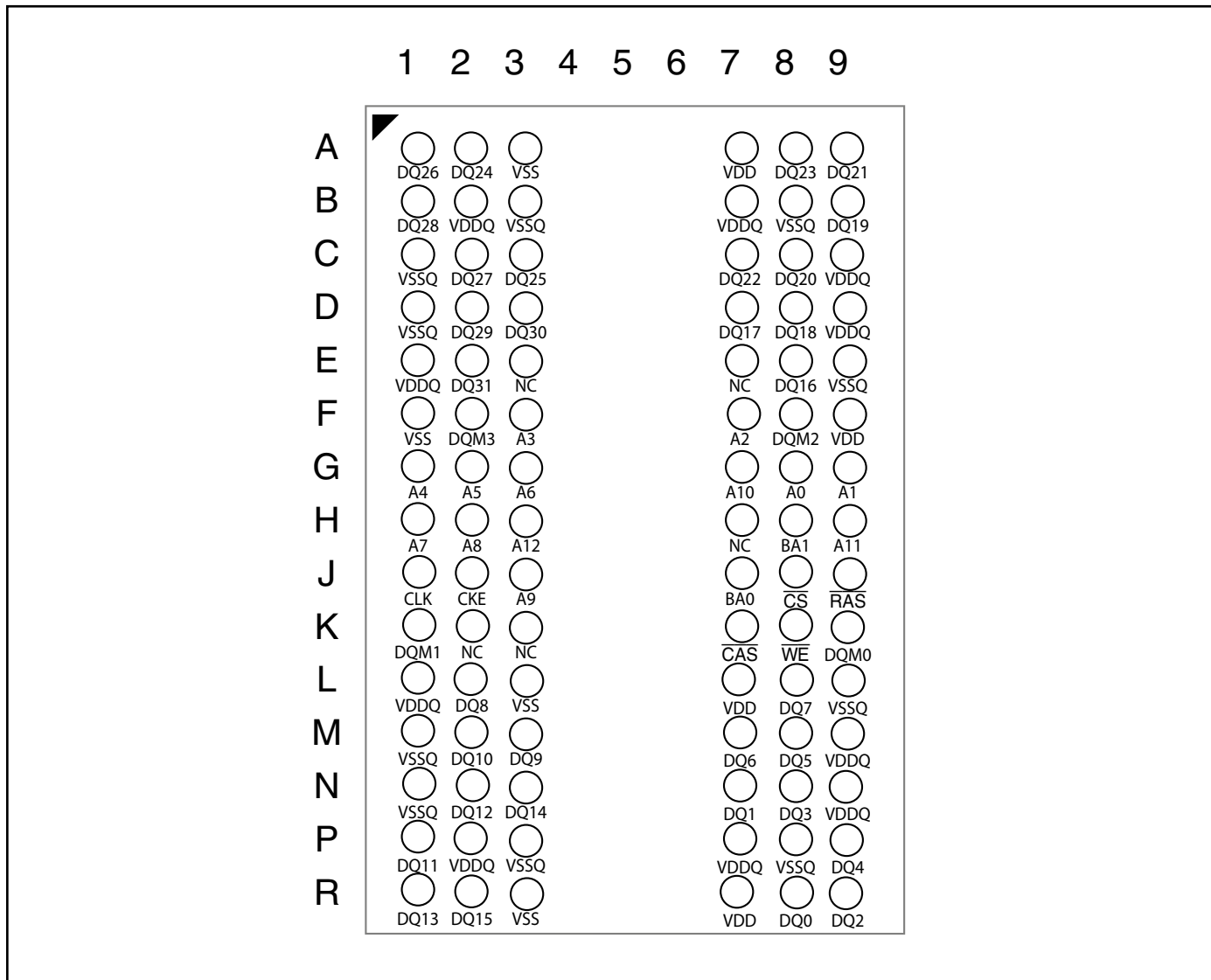
### PIN DESCRIPTIONS

A0-A12	Row Address Input
A0-A9	Column Address Input
BA0, BA1	Bank Select Address
DQ0 to DQ15	Data I/O
CLK	System Clock Input
CKE	Clock Enable
$\overline{CS}$	Chip Select
$\overline{RAS}$	Row Address Strobe Command
$\overline{CAS}$	Column Address Strobe Command

$\overline{WE}$	Write Enable
DQML	x16 Lower Byte Input/Output Mask
DQMH	x16 Upper Byte Input/Output Mask
V <sub>DD</sub>	Power
V <sub>SS</sub>	Ground
V <sub>DDQ</sub>	Power Supply for I/O Pin
V <sub>SSQ</sub>	Ground for I/O Pin
NC	No Connection

**PIN CONFIGURATION**

PACKAGE CODE: B 90 BALL TF-BGA (Top View) (8.00 mm x 13.00 mm Body, 0.8 mm Ball Pitch)



**PIN DESCRIPTIONS**

A0-A12	Row Address Input
A0-A8	Column Address Input
BA0, BA1	Bank Select Address
DQ0 to DQ31	Data I/O
CLK	System Clock Input
CKE	Clock Enable
$\overline{CS}$	Chip Select
$\overline{RAS}$	Row Address Strobe Command
$\overline{CAS}$	Column Address Strobe Command

$\overline{WE}$	Write Enable
DQM0-DQM3	x32 Input/Output Mask
V <sub>DD</sub>	Power
V <sub>SS</sub>	Ground
V <sub>DDQ</sub>	Power Supply for I/O Pin
V <sub>SSQ</sub>	Ground for I/O Pin
NC	No Connection

**PIN FUNCTIONS**

Symbol	Type	Function (In Detail)
A0-A12	Input Pin	Address Inputs: A0-A12 are sampled during the ACTIVE command (row-address A0-A12) and READ/WRITE command (column address A0-A9, A11 (x8); A0-A9 (x16); A0-A8 (x32); with A10 defining auto precharge) to select one location out of the memory array in the respective bank. A10 is sampled during a PRECHARGE command to determine if all banks are to be precharged (A10 HIGH) or bank selected by BA0, BA1 (LOW). The address inputs also provide the op-code during a LOAD MODE REGISTER command.
BA0, BA1	Input Pin	Bank Select Address: BA0 and BA1 defines which bank the ACTIVE, READ, WRITE or PRECHARGE command is being applied.
$\overline{\text{CAS}}$	Input Pin	$\overline{\text{CAS}}$ , in conjunction with the $\overline{\text{RAS}}$ and $\overline{\text{WE}}$ , forms the device command. See the "Command Truth Table" for details on device commands.
CKE	Input Pin	The CKE input determines whether the CLK input is enabled. The next rising edge of the CLK signal will be valid when is CKE HIGH and invalid when LOW. When CKE is LOW, the device will be in either power-down mode, clock suspend mode, or self refresh mode. CKE is an asynchronous input.
CLK	Input Pin	CLK is the master clock input for this device. Except for CKE, all inputs to this device are acquired in synchronization with the rising edge of this pin.
$\overline{\text{CS}}$	Input Pin	The $\overline{\text{CS}}$ input determines whether command input is enabled within the device. Command input is enabled when $\overline{\text{CS}}$ is LOW, and disabled with $\overline{\text{CS}}$ is HIGH. The device remains in the previous state when $\overline{\text{CS}}$ is HIGH.
DQM: x8 DQML, DQMH: x16 DQM0-DQM3: x32	Input Pin	DQx pins control the bytes of the I/O buffers. For example with x16, in read mode, DQML and DQMH control the output buffer. When DQML or DQMH is LOW, the corresponding buffer byte is enabled, and when HIGH, disabled. The outputs go to the HIGH impedance state when DQML/DQMH is HIGH. This function corresponds to $\overline{\text{OE}}$ in conventional DRAMs. In write mode, DQML and DQMH control the input buffer. When DQML or DQMH is LOW, the corresponding buffer byte is enabled, and data can be written to the device. When DQML or DQMH is HIGH, input data is masked and cannot be written to the device.
DQ0-DQ7: x8 DQ0-DQ15: x16 DQ0-DQ31: x32	Input/Output	Data on the Data Bus is latched on DQ pins during Write commands, and buffered for output after Read commands.
$\overline{\text{RAS}}$	Input Pin	$\overline{\text{RAS}}$ , in conjunction with $\overline{\text{CAS}}$ and $\overline{\text{WE}}$ , forms the device command. See the "Command Truth Table" item for details on device commands.
$\overline{\text{WE}}$	Input Pin	$\overline{\text{WE}}$ , in conjunction with $\overline{\text{RAS}}$ and $\overline{\text{CAS}}$ , forms the device command. See the "Command Truth Table" item for details on device commands.
V <sub>DDQ</sub>	Power Supply Pin	V <sub>DDQ</sub> is the output buffer power supply.
V <sub>DD</sub>	Power Supply Pin	V <sub>DD</sub> is the device internal power supply.
V <sub>SSQ</sub>	Power Supply Pin	V <sub>SSQ</sub> is the output buffer ground.
V <sub>SS</sub>	Power Supply Pin	V <sub>SS</sub> is the device internal ground.



## GENERAL DESCRIPTION

### READ

The READ command selects the bank from BA0, BA1 inputs and starts a burst read access to an active row. Inputs A0-An (For column addresses, n=A8 for x32, n=A9 for x16, n=A11 for x8), provides the starting column location. When A10 is HIGH, this command functions as an AUTO PRECHARGE command. When the auto precharge is selected, the row being accessed will be precharged at the end of the READ burst. The row will remain open for subsequent accesses when AUTO PRECHARGE is not selected. DQ's read data is subject to the logic level on the DQM inputs two clocks earlier. When a given DQM signal was registered HIGH, the corresponding DQ's will be High-Z two clocks later. DQ's will provide valid data when the DQM signal was registered LOW.

### WRITE

A burst write access to an active row is initiated with the WRITE command. BA0, BA1 inputs selects the bank, and the starting column location is provided by inputs A0-An (For column addresses, n=A8 for x32, n=A9 for x16, n=A11 for x8). AUTO-PRECHARGE is determined by A10.

The row being accessed will be precharged at the end of the WRITE burst, if AUTO PRECHARGE is selected. If AUTO PRECHARGE is not selected, the row will remain open for subsequent accesses.

A memory array is written with corresponding input data on DQ's and DQM input logic level appearing at the same time. Data will be written to memory when DQM signal is LOW. When DQM is HIGH, the corresponding data inputs will be ignored, and a WRITE will not be executed to that byte/column location.

### PRECHARGE

The PRECHARGE command is used to deactivate the open row in a particular bank or the open row in all banks. BA0, BA1 can be used to select which bank is precharged or they are treated as "Don't Care". A10 determined whether one or all banks are precharged. After executing this command, the next command for the selected bank(s) is executed after passage of the period  $t_{RP}$  which is the period required for bank precharging. Once a bank has been precharged, it is in the idle state and must be activated prior to any READ or WRITE commands being issued to that bank.

### AUTO PRECHARGE

The AUTO PRECHARGE function ensures that the precharge is initiated at the earliest valid stage within a burst. This function allows for individual-bank precharge without

requiring an explicit command. A10 to enable the AUTO PRECHARGE function in conjunction with a specific READ or WRITE command. For each individual READ or WRITE command, auto precharge is either enabled or disabled. AUTO PRECHARGE does not apply except in full-page burst mode. Upon completion of the READ or WRITE burst, a precharge of the bank/row that is addressed is automatically performed.

### AUTO REFRESH COMMAND

This command executes the AUTO REFRESH operation. The row address and bank to be refreshed are automatically generated during this operation. The stipulated period ( $t_{RC}$ ) is required for a single refresh operation, and no other commands can be executed during this period. This command is executed at least 8192 times for every  $T_{REF}$  period. During an AUTO REFRESH command, address bits are "Don't Care". This command corresponds to CBR Auto-refresh.

### BURST TERMINATE

The BURST TERMINATE command forcibly terminates the burst read and write operations by truncating either fixed-length or full-page bursts and the most recently registered READ or WRITE command prior to the BURST TERMINATE.

### COMMAND INHIBIT

COMMAND INHIBIT prevents new commands from being executed. Operations in progress are not affected, apart from whether the CLK signal is enabled

### NO OPERATION

When  $\overline{CS}$  is low, the NOP command prevents unwanted commands from being registered during idle or wait states.

### LOAD MODE REGISTER

During the LOAD MODE REGISTER command the mode register is loaded from A0-A12. This command can only be issued when all banks are idle.

### ACTIVE COMMAND

When the ACTIVE COMMAND is activated, BA0, BA1 inputs selects a bank to be accessed, and the address inputs on A0-A12 selects the row. Until a PRECHARGE command is issued to the bank, the row remains open for accesses.

**COMMAND TRUTH TABLE**

Function	CKE		$\overline{CS}$	$\overline{RAS}$	$\overline{CAS}$	$\overline{WE}$	BA1	BA0	A12, A11	
	n - 1	n							A10	A9 - A0
Device deselect (DESL)	H	x	H	x	x	x	x	x	x	x
No operation (NOP)	H	x	L	H	H	H	x	x	x	x
Burst stop (BST)	H	x	L	H	H	L	x	x	x	x
Read	H	x	L	H	L	H	V	V	L	V
Read with auto precharge	H	x	L	H	L	H	V	V	H	V
Write	H	x	L	H	L	L	V	V	L	V
Write with auto precharge	H	x	L	H	L	L	V	V	H	V
Bank activate (ACT)	H	x	L	L	H	H	V	V	V	V
Precharge select bank (PRE)	H	x	L	L	H	L	V	V	L	x
Precharge all banks (PALL)	H	x	L	L	H	L	x	x	H	x
CBR Auto-Refresh (REF)	H	H	L	L	L	H	x	x	x	x
Self-Refresh (SELF)	H	L	L	L	L	H	x	x	x	x
Mode register set (MRS)	H	x	L	L	L	L	L	L	L	V

Note: H=V<sub>IH</sub>, L=V<sub>IL</sub> x= V<sub>IH</sub> or V<sub>IL</sub>, V = Valid Data.

**DQM TRUTH TABLE**

Function	CKE		DQMH	DQML
	n-1	n		
Data write / output enable	H	x	L	L
Data mask / output disable	H	x	H	H
Upper byte write enable / output enable	H	x	L	x
Lower byte write enable / output enable	H	x	x	L
Upper byte write inhibit / output disable	H	x	H	x
Lower byte write inhibit / output disable	H	x	x	H

Note:

1. H=V<sub>IH</sub>, L=V<sub>IL</sub> x= V<sub>IH</sub> or V<sub>IL</sub>, V = Valid Data.
2. x16 options shown. x32 DQM0-DQM3 is similar in function.

## CKE TRUTH TABLE

Current State /Function	CKE		$\overline{\text{CS}}$	$\overline{\text{RAS}}$	$\overline{\text{CAS}}$	$\overline{\text{WE}}$	Address
	n - 1	n					
Activating Clock suspend mode entry	H	L	x	x	x	x	x
Any Clock suspend mode	L	L	x	x	x	x	x
Clock suspend mode exit	L	H	x	x	x	x	x
Auto refresh command Idle (REF)	H	H	L	L	L	H	x
Self refresh entry Idle (SELF)	H	L	L	L	L	H	x
Power down entry Idle	H	L	x	x	x	x	x
Self refresh exit	L	H	L	H	H	H	x
	L	H	H	x	x	x	x
Power down exit	L	H	x	x	x	x	x

Note: H= $V_{IH}$ , L= $V_{IL}$  x=  $V_{IH}$  or  $V_{IL}$ , V = Valid Data.

**FUNCTIONAL TRUTH TABLE**

Current State	$\overline{CS}$	$\overline{RAS}$	$\overline{CAS}$	$\overline{WE}$	Address	Command	Action
Idle	H	X	X	X	X	DESL	Nop or Power Down <sup>(2)</sup>
	L	H	H	H	X	NOP	Nop or Power Down <sup>(2)</sup>
	L	H	H	L	X	BST	Nop or Power Down
	L	H	L	H	BA, CA, A10	READ/READA	ILLEGAL <sup>(3)</sup>
	L	H	L	L	A, CA, A10	WRIT/ WRITA	ILLEGAL <sup>(3)</sup>
	L	L	H	H	BA, RA	ACT	Row activating
	L	L	H	L	BA, A10	PRE/PALL	Nop
	L	L	L	H	X	REF/SELF	Auto refresh or Self-refresh <sup>(4)</sup>
	L	L	L	L	OC, BA1=L	MRS	Mode register set
Row Active	H	X	X	X	X	DESL	Nop
	L	H	H	H	X	NOP	Nop
	L	H	H	L	X	BST	Nop
	L	H	L	H	BA, CA, A10	READ/READA	Begin read <sup>(5)</sup>
	L	H	L	L	BA, CA, A10	WRIT/ WRITA	Begin write <sup>(5)</sup>
	L	L	H	H	BA, RA	ACT	ILLEGAL <sup>(3)</sup>
	L	L	H	L	BA, A10	PRE/PALL	Precharge Precharge all banks <sup>(6)</sup>
	L	L	L	H	X	REF/SELF	ILLEGAL
	L	L	L	L	OC, BA	MRS	ILLEGAL
Read	H	X	X	X	X	DESL	Continue burst to end to Row active
	L	H	H	H	X	NOP	Continue burst to end Row Row active
	L	H	H	L	X	BST	Burst stop, Row active
	L	H	L	H	BA, CA, A10	READ/READA	Terminate burst, begin new read <sup>(7)</sup>
	L	H	L	L	BA, CA, A10	WRIT/WRITA	Terminate burst, begin write <sup>(7,8)</sup>
	L	L	H	H	BA, RA	ACT	ILLEGAL <sup>(3)</sup>
	L	L	H	L	BA, A10	PRE/PALL	Terminate burst Precharging
	L	L	L	H	X	REF/SELF	ILLEGAL
	L	L	L	L	OC, BA	MRS	ILLEGAL
Write	H	X	X	X	X	DESL	Continue burst to end Write recovering
	L	H	H	H	X	NOP	Continue burst to end Write recovering
	L	H	H	L	X	BST	Burst stop, Row active
	L	H	L	H	BA, CA, A10	READ/READA	Terminate burst, start read : Determine AP <sup>(7,8)</sup>
	L	H	L	L	BA, CA, A10	WRIT/WRITA	Terminate burst, new write : Determine AP <sup>(7)</sup>
	L	L	H	H	BA, RA	RA ACT	ILLEGAL <sup>(3)</sup>
	L	L	H	L	BA, A10	PRE/PALL	Terminate burst Precharging <sup>(9)</sup>
	L	L	L	H	X	REF/SELF	ILLEGAL
	L	L	L	L	OC, BA	MRS	ILLEGAL

Note: H=V<sub>IH</sub>, L=V<sub>IL</sub> x= V<sub>IH</sub> or V<sub>IL</sub>, V = Valid Data, BA= Bank Address, CA+Column Address, RA=Row Address, OC= Op-Code

## FUNCTIONAL TRUTH TABLE Continued:

Current State	$\overline{CS}$	$\overline{RAS}$	$\overline{CAS}$	$\overline{WE}$	Address	Command	Action
Read with auto Precharging	H	x	x	x	x	DESL	Continue burst to end, Precharge
	L	H	H	H	x	NOP	Continue burst to end, Precharge
	L	H	H	L	x	BST	ILLEGAL
	L	H	L	H	BA, CA, A10	READ/READA	ILLEGAL <sup>(11)</sup>
	L	H	L	L	BA, CA, A10	WRIT/WRITA	ILLEGAL <sup>(11)</sup>
	L	L	H	H	BA, RA	ACT	ILLEGAL <sup>(3)</sup>
	L	L	H	L	BA, A10	PRE/PALL	ILLEGAL <sup>(11)</sup>
	L	L	L	H	x	REF/SELF	ILLEGAL
	L	L	L	L	OC, BA	MRS	ILLEGAL
Write with Auto Precharge	H	x	x	x	x	DESL	Continue burst to end, Write recovering with auto precharge
	L	H	H	H	x	NOP	Continue burst to end, Write recovering with auto precharge
	L	H	H	L	x	BST	ILLEGAL
	L	H	L	H	BA, CA, A10	READ/READA	ILLEGAL <sup>(11)</sup>
	L	H	L	L	BA, CA, A10	WRIT/WRITA	ILLEGAL <sup>(11)</sup>
	L	L	H	H	BA, RA	ACT	ILLEGAL <sup>(3,11)</sup>
	L	L	H	L	BA, A10	PRE/PALL	ILLEGAL <sup>(3,11)</sup>
	L	L	L	H	x	REF/SELF	ILLEGAL
	L	L	L	L	OC, BA	MRS	ILLEGAL
Precharging	H	x	x	x	x	DESL	Nop, Enter idle after tRP
	L	H	H	H	x	NOP	Nop, Enter idle after tRP
	L	H	H	L	x	BST	Nop, Enter idle after tRP
	L	H	L	H	BA, CA, A10	READ/READA	ILLEGAL <sup>(3)</sup>
	L	H	L	L	BA, CA, A10	WRIT/WRITA	ILLEGAL <sup>(3)</sup>
	L	L	H	H	BA, RA	ACT	ILLEGAL <sup>(3)</sup>
	L	L	H	L	BA, A10	PRE/PALL	Nop Enter idle after tRP
	L	L	L	H	x	REF/SELF	ILLEGAL
	L	L	L	L	OC, BA	MRS	ILLEGAL
Row Activating	H	x	x	x	x	DESL	Nop, Enter bank active after tRCD
	L	H	H	H	x	NOP	Nop, Enter bank active after tRCD
	L	H	H	L	x	BST	Nop, Enter bank active after tRCD
	L	H	L	H	BA, CA, A10	READ/READA	ILLEGAL <sup>(3)</sup>
	L	H	L	L	BA, CA, A10	WRIT/WRITA	ILLEGAL <sup>(3)</sup>
	L	L	H	H	BA, RA	ACT	ILLEGAL <sup>(3,9)</sup>
	L	L	H	L	BA, A10	PRE/PALL	ILLEGAL <sup>(3)</sup>
	L	L	L	H	x	REF/SELF	ILLEGAL
	L	L	L	L	OC, BA	MRS	ILLEGAL

Note: H=V<sub>IH</sub>, L=V<sub>IL</sub> x= V<sub>IH</sub> or V<sub>IL</sub>, V = Valid Data, BA= Bank Address, CA+Column Address, RA=Row Address, OC= Op-Code

**FUNCTIONAL TRUTH TABLE Continued:**

Current State	CS	RAS	CAS	WE	Address	Command	Action
Write Recovering	H	x	x	x	x	DESL	Nop, Enter row active after tDPL
	L	H	H	H	x	NOP	Nop, Enter row active after tDPL
	L	H	H	L	x	BST	Nop, Enter row active after tDPL
	L	H	L	H	BA, CA, A10	READ/READA	Begin read <sup>(8)</sup>
	L	H	L	L	BA, CA, A10	WRIT/WRITA	Begin new write
	L	L	H	H	BA, RA	ACT	ILLEGAL <sup>(3)</sup>
	L	L	H	L	BA, A10	PRE/PALL	ILLEGAL <sup>(3)</sup>
	L	L	L	H	x	REF/SELF	ILLEGAL
Write Recovering with Auto Precharge	L	L	L	L	OC, BA	MRS	ILLEGAL
	H	x	x	x	x	DESL	Nop, Enter precharge after tDPL
	L	H	H	H	x	NOP	Nop, Enter precharge after tDPL
	L	H	H	L	x	BST	Nop, Enter row active after tDPL
	L	H	L	H	BA, CA, A10	READ/READA	ILLEGAL <sup>(3,8,11)</sup>
	L	H	L	L	BA, CA, A10	WRIT/WRITA	ILLEGAL <sup>(3,11)</sup>
	L	L	H	H	BA, RA	ACT	ILLEGAL <sup>(3,11)</sup>
	L	L	H	L	BA, A10	PRE/PALL	ILLEGAL <sup>(3,11)</sup>
Refresh	L	L	L	H	x	REF/SELF	ILLEGAL
	L	L	L	L	OC, BA	MRS	ILLEGAL
	H	x	x	x	x	DESL	Nop, Enter idle after tRC
	L	H	H	x	x	NOP/BST	Nop, Enter idle after tRC
	L	H	L	H	BA, CA, A10	READ/READA	ILLEGAL
	L	H	L	L	BA, CA, A10	WRIT/WRITA	ILLEGAL
	L	L	H	H	BA, RA	ACT	ILLEGAL
	L	L	H	L	BA, A10	PRE/PALL	ILLEGAL
Mode Register Accessing	L	L	L	H	x	REF/SELF	ILLEGAL
	L	L	L	L	OC, BA	MRS	ILLEGAL
	H	x	x	x	x	DESL	Nop, Enter idle after 2 clocks
	L	H	H	H	x	NOP	Nop, Enter idle after 2 clocks
	L	H	H	L	x	BST	ILLEGAL
	L	H	L	x	BA, CA, A10	READ/WRITE	ILLEGAL
	L	L	x	x	BA, RA	ACT/PRE/PALL REF/MRS	ILLEGAL

Note: H=V<sub>IH</sub>, L=V<sub>IL</sub>, x= V<sub>IH</sub> or V<sub>IL</sub>, V = Valid Data, BA= Bank Address, CA+Column Address, RA=Row Address, OC= Op-Code

**Notes:**

1. All entries assume that CKE is active (CKE<sub>n-1</sub>=CKE<sub>n</sub>=H).
2. If both banks are idle, and CKE is inactive (Low), the device will enter Power Down mode. All input buffers except CKE will be disabled.
3. Illegal to bank in specified states; Function may be legal in the bank indicated by Bank Address (BA), depending on the state of that bank.
4. If both banks are idle, and CKE is inactive (Low), the device will enter Self-Refresh mode. All input buffers except CKE will be disabled.
5. Illegal if tRCD is not satisfied.
6. Illegal if tRAS is not satisfied.
7. Must satisfy burst interrupt condition.
8. Must satisfy bus contention, bus turn around, and/or write recovery requirements.
9. Must mask preceding data which don't satisfy tDPL.
10. Illegal if tRRD is not satisfied.
11. Illegal for single bank, but legal for other banks.

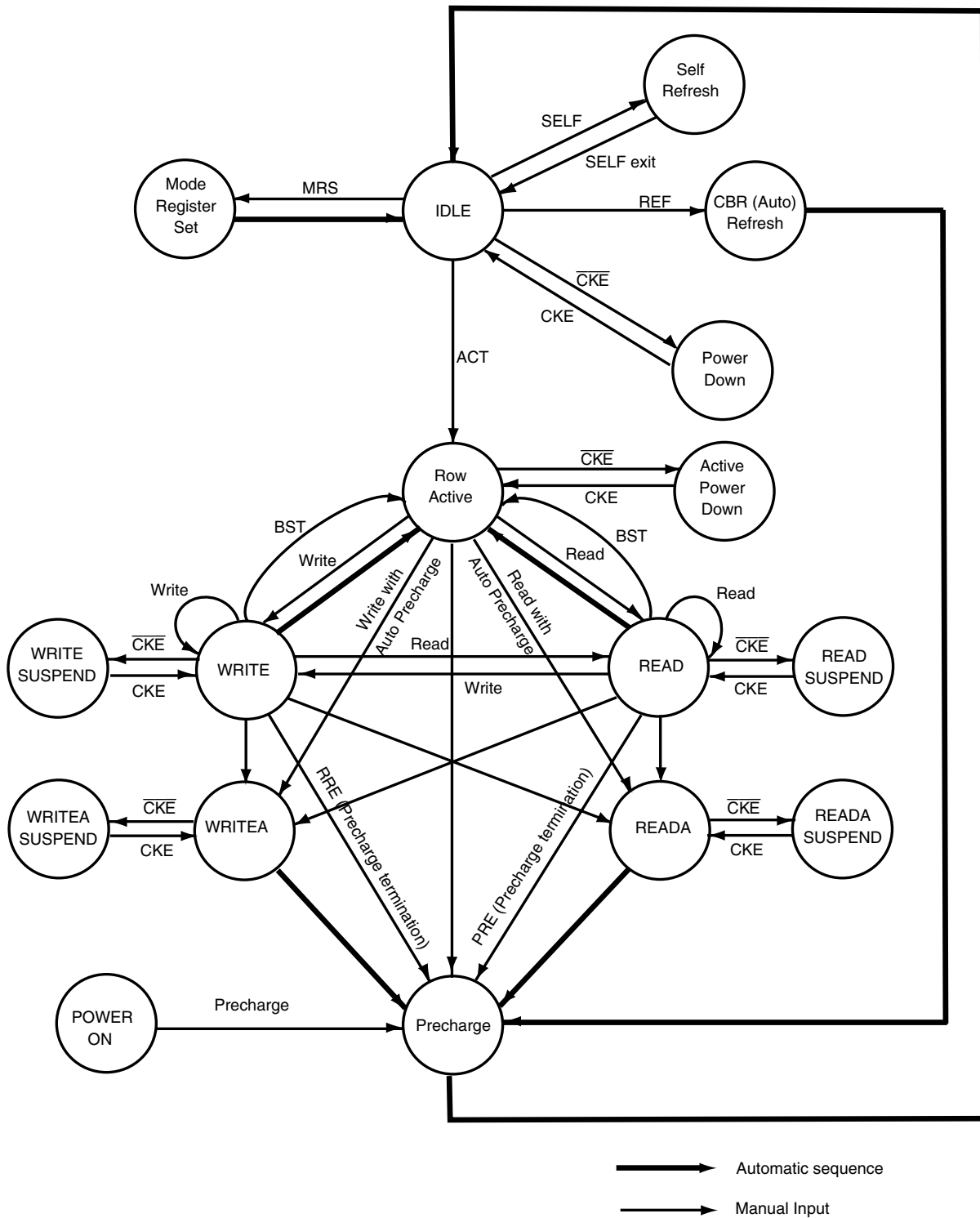
**CKE RELATED COMMAND TRUTH TABLE<sup>(1)</sup>**

Current State	Operation	CKE		$\overline{CS}$	$\overline{RAS}$	$\overline{CAS}$	$\overline{WE}$	Address
		n-1	n					
Self-Refresh (S.R.)	INVALID, CLK (n - 1) would exit S.R.	H	X	X	X	X	X	X
	Self-Refresh Recovery <sup>(2)</sup>	L	H	H	X	X	X	X
	Self-Refresh Recovery <sup>(2)</sup>	L	H	L	H	H	X	X
	Illegal	L	H	L	H	L	X	X
	Illegal	L	H	L	L	X	X	X
	Maintain S.R.	L	L	X	X	X	X	X
Self-Refresh Recovery Idle After $t_{RC}$	Idle After $t_{RC}$	H	H	H	X	X	X	X
	Idle After $t_{RC}$	H	H	L	H	H	X	X
	Illegal	H	H	L	H	L	X	X
	Illegal	H	H	L	L	X	X	X
	Begin clock suspend next cycle <sup>(5)</sup>	H	L	H	X	X	X	X
	Begin clock suspend next cycle <sup>(5)</sup>	H	L	L	H	H	X	X
	Illegal	H	L	L	H	L	X	X
	Illegal	H	L	L	L	X	X	X
	Exit clock suspend next cycle <sup>(2)</sup>	L	H	X	X	X	X	X
	Maintain clock suspend	L	L	X	X	X	X	X
Power-Down (P.D.)	INVALID, CLK (n - 1) would exit P.D.	H	X	X	X	X	X	—
	EXIT P.D. --> Idle <sup>(2)</sup>	L	H	X	X	X	X	X
	Maintain power down mode	L	L	X	X	X	X	X
All Banks Idle	Refer to operations in Operative Command Table	H	H	H	X	X	X	—
	Refer to operations in Operative Command Table	H	H	L	H	X	X	—
	Refer to operations in Operative Command Table	H	H	L	L	H	X	—
	Auto-Refresh	H	H	L	L	L	H	X
	Refer to operations in Operative Command Table	H	H	L	L	L	L	Op - Code
	Refer to operations in Operative Command Table	H	L	H	X	X	X	—
	Refer to operations in Operative Command Table	H	L	L	H	X	X	—
	Refer to operations in Operative Command Table	H	L	L	L	H	X	—
	Self-Refresh <sup>(3)</sup>	H	L	L	L	L	H	X
	Refer to operations in Operative Command Table	H	L	L	L	L	L	Op - Code
Power-Down <sup>(3)</sup>	L	X	X	X	X	X	X	
Any state other than listed above	Refer to operations in Operative Command Table	H	H	X	X	X	X	X
	Begin clock suspend next cycle <sup>(4)</sup>	H	L	X	X	X	X	X
	Exit clock suspend next cycle	L	H	X	X	X	X	X
	Maintain clock suspend	L	L	X	X	X	X	X

**Notes:**

1. H : High level, L : low level, X : High or low level (Don't care).
2. CKE Low to High transition will re-enable CLK and other inputs asynchronously. A minimum setup time must be satisfied before any command other than EXIT.
3. Power down and Self refresh can be entered only from the both banks idle state.
4. Must be legal command as defined in Operative Command Table.
5. Illegal if txsr is not satisfied.

STATE DIAGRAM





**ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>**

Symbol	Parameters	Rating	Unit
V <sub>DD MAX</sub>	Maximum Supply Voltage	-0.5 to +4.6	V
V <sub>DDQ MAX</sub>	Maximum Supply Voltage for Output Buffer	-0.5 to +4.6	V
V <sub>IN</sub>	Input Voltage	-0.5 to V <sub>DD</sub> + 0.5	V
V <sub>OUT</sub>	Output Voltage	-1.0 to V <sub>DDQ</sub> + 0.5	V
P <sub>D MAX</sub>	Allowable Power Dissipation	1	W
I <sub>CS</sub>	Output Shorted Current	50	mA
T <sub>OPR</sub>	Operating Temperature	Com. 0 to +70 Ind. -40 to +85 A1 -40 to +85 A2 -40 to +105	°C
T <sub>STG</sub>	Storage Temperature	-65 to +150	°C

**Notes:**

1. Stress greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.
2. All voltages are referenced to V<sub>SS</sub>.

**DC RECOMMENDED OPERATING CONDITIONS****IS42/45SxxxxxD - 3.3V Operation**

Symbol	Parameters	Min.	Typ.	Max.	Unit
V <sub>DD</sub>	Supply Voltage	3.0	3.3	3.6	V
V <sub>DDQ</sub>	I/O Supply Voltage	3.0	3.3	3.6	V
V <sub>IH</sub> <sup>(1)</sup>	Input High Voltage	2.0	-	V <sub>DDQ</sub> +0.3	V
V <sub>IL</sub> <sup>(2)</sup>	Input Low Voltage	-0.3	-	0.8	V
I <sub>IL</sub>	Input Leakage Current (0V ≤ V <sub>IN</sub> ≤ V <sub>DD</sub> )	-5	-	+5	μA
I <sub>OL</sub>	Output Leakage Current (Output disabled, 0V ≤ V <sub>OUT</sub> ≤ V <sub>DD</sub> )	-5	-	+5	μA
V <sub>OH</sub>	Output High Voltage Current (I <sub>OH</sub> = -2mA)	2.4	-	-	V
V <sub>OL</sub>	Output Low Voltage Current (I <sub>OL</sub> = 2mA)	-	-	0.4	V

**IS42/45RxxxxxD - 2.5V Operation**

Symbol	Parameters	Min.	Typ.	Max.	Unit
V <sub>DD</sub>	Supply Voltage	2.3	2.5	2.7	V
V <sub>DDQ</sub>	I/O Supply Voltage	2.3	2.5	2.7	V
V <sub>IH</sub> <sup>(1)</sup>	Input High Voltage	2.0	-	V <sub>DDQ</sub> +0.3	V
V <sub>IL</sub> <sup>(2)</sup>	Input Low Voltage	-0.3	-	0.55	V
I <sub>IL</sub>	Input Leakage Current (0V ≤ V <sub>IN</sub> ≤ V <sub>DD</sub> )	-5	-	+5	μA
I <sub>OL</sub>	Output Leakage Current (Output disabled, 0V ≤ V <sub>OUT</sub> ≤ V <sub>DD</sub> )	-5	-	+5	μA
V <sub>OH</sub>	Output High Voltage Current (I <sub>OH</sub> = -2mA)	V <sub>DDQ</sub> -0.2	-	-	V
V <sub>OL</sub>	Output Low Voltage Current (I <sub>OL</sub> = 2mA)	-	-	0.2	V

**Notes:**

1. V<sub>IH</sub> (overshoot): V<sub>IH</sub> (max) = V<sub>DDQ</sub> + 1.2V (pulse width < 3ns).
2. V<sub>IL</sub> (undershoot): V<sub>IL</sub> (min) = -1.2V (pulse width < 3ns).
3. All voltages are referenced to V<sub>SS</sub>.

**CAPACITANCE CHARACTERISTICS<sup>(1)</sup>** (At  $T_A = 0$  to  $+25^\circ\text{C}$ ,  $V_{DD} = V_{DDQ} = 3.3 \pm 0.3\text{V}$ ,  $f = 1\text{MHz}$ )

Symbol	Parameter	Min.	Max.	Unit
C <sub>IN1</sub>	Input Capacitance: CLK	2.5	3.5	pF
C <sub>IN2</sub>	Input Capacitance: All other input pins	2.5	3.8	pF
C <sub>I/O</sub>	Data Input/Output Capacitance: DQS	4.0	6.0	pF

**Note:** 1. The parameter is characterized.

**THERMAL RESISTANCE**

Package	Substrate	Theta-ja (Airflow = 0m/s)	Theta-ja (Airflow = 1m/s)	Theta-ja (Airflow = 2m/s)	Theta-jc	Units
Alloy42 TSOP2(54)	4-layer	53.3	45.2	42.0	7.8	C/W
Copper TSOP2(54)	4-layer	42.3	37.1	34.5	7.5	C/W
BGA(54)	4-layer	36.7	30.5	28.9	4.2	C/W
BGA(90)	4-layer	36.1	30.7	27.7	3.0	C/W

**DC ELECTRICAL CHARACTERISTICS (x8, x16)**

(Recommended Operation Conditions unless otherwise noted.)

Symbol	Parameter	Test Condition	-5	-6	-7	Unit
I <sub>DD1</sub> <sup>(1)</sup>	Operating Current	One bank active, CL = 3, BL = 1, t <sub>CLK</sub> = t <sub>CLK</sub> (min), t <sub>RC</sub> = t <sub>RC</sub> (min)	170	150	140	mA
I <sub>DD2P</sub>	Precharge Standby Current (In Power-Down Mode)	CKE ≤ V <sub>IL</sub> (MAX), t <sub>CK</sub> = 15ns	8	8	8	mA
I <sub>DD2PS</sub>	Precharge Standby Current (In Power-Down Mode)	CKE ≤ V <sub>IL</sub> (MAX), CLK ≤ V <sub>IL</sub> (MAX)	8	8	8	mA
I <sub>DD2N</sub> <sup>(2)</sup>	Precharge Standby Current (In Non Power-Down Mode)	$\overline{\text{CS}} \geq V_{CC} - 0.2\text{V}$ , CKE ≥ V <sub>IH</sub> (MIN) t <sub>CK</sub> = 15ns	35	35	35	mA
I <sub>DD2NS</sub>	Precharge Standby Current (In Non Power-Down Mode)	$\overline{\text{CS}} \geq V_{CC} - 0.2\text{V}$ , CKE ≥ V <sub>IH</sub> (MIN) or CKE ≤ V <sub>IL</sub> (MAX), All inputs stable	30	30	30	mA
I <sub>DD3P</sub>	Active Standby Current (Power-Down Mode)	CKE ≤ V <sub>IL</sub> (MAX), t <sub>CK</sub> = 15ns	15	15	15	mA
I <sub>DD3PS</sub>	Active Standby Current (Power-Down Mode)	CKE ≤ V <sub>IL</sub> (MAX), CLK ≤ V <sub>IL</sub> (MAX)	15	15	15	mA
I <sub>DD3N</sub> <sup>(2)</sup>	Active Standby Current (In Non Power-Down Mode)	$\overline{\text{CS}} \geq V_{CC} - 0.2\text{V}$ , CKE ≥ V <sub>IH</sub> (MIN) t <sub>CK</sub> = 15ns	40	40	40	mA
I <sub>DD3NS</sub>	Active Standby Current (In Non Power-Down Mode)	$\overline{\text{CS}} \geq V_{CC} - 0.2\text{V}$ , CKE ≥ V <sub>IH</sub> (MIN) or CKE ≤ V <sub>IL</sub> (MAX), All inputs stable	30	30	30	mA
I <sub>DD4</sub>	Operating Current	All banks active, BL = 4, CL = 3, t <sub>CK</sub> = t <sub>CK</sub> (min)	200	180	160	mA
I <sub>DD5</sub>	Auto-Refresh Current	t <sub>RC</sub> = t <sub>RC</sub> (min), t <sub>CLK</sub> = t <sub>CLK</sub> (min)	250	230	210	mA
I <sub>DD6</sub>	Self-Refresh Current	CKE ≤ 0.2V	12	12	12	mA

**Notes:**

- I<sub>DD</sub> (MAX) is specified at the output open condition.
- Input signals are changed one time during 30ns.
- All values applicable for operation with  $T_A \leq 85^\circ\text{C}$ .
- For A2 temperature grade with  $T_A > 85^\circ\text{C}$ : I<sub>DD2P</sub> and I<sub>DD2PS</sub> are derated to 50% above the values; I<sub>DD3P</sub> and I<sub>DD3PS</sub> are derated to 30% above the values.

## DC ELECTRICAL CHARACTERISTICS (x32)

(Recommended Operation Conditions unless otherwise noted.)

Symbol	Parameter	Test Condition	-5	-6	-7	Unit
I <sub>DD1</sub> <sup>(1)</sup>	Operating Current	One bank active, CL = 3, BL = 1, t <sub>CLK</sub> = t <sub>CLK</sub> (min), t <sub>RC</sub> = t <sub>RC</sub> (min)	190	180	170	mA
I <sub>DD2P</sub>	Precharge Standby Current (In Power-Down Mode)	CKE ≤ V <sub>IL</sub> (MAX), t <sub>CK</sub> = 15ns	4	4	4	mA
I <sub>DD2PS</sub>	Precharge Standby Current (In Power-Down Mode)	CKE ≤ V <sub>IL</sub> (MAX), CLK ≤ V <sub>IL</sub> (MAX)	4	4	4	mA
I <sub>DD2N</sub> <sup>(2)</sup>	Precharge Standby Current (In Non Power-Down Mode)	$\overline{CS} \geq V_{DD} - 0.2V$ , CKE ≥ V <sub>IH</sub> (MIN) t <sub>CK</sub> = 15ns	45	45	45	mA
I <sub>DD2NS</sub>	Precharge Standby Current (In Non Power-Down Mode)	$\overline{CS} \geq V_{DD} - 0.2V$ , CKE ≥ V <sub>IH</sub> (MIN) or CKE ≤ V <sub>IL</sub> (MAX), All inputs stable	20	20	20	mA
I <sub>DD3P</sub>	Active Standby Current (Power-Down Mode)	CKE ≤ V <sub>IL</sub> (MAX), t <sub>CK</sub> = 15ns	15	15	15	mA
I <sub>DD3PS</sub>	Active Standby Current (Power-Down Mode)	CKE ≤ V <sub>IL</sub> (MAX), CLK ≤ V <sub>IL</sub> (MAX)	15	15	15	mA
I <sub>DD3N</sub> <sup>(2)</sup>	Active Standby Current (In Non Power-Down Mode)	$\overline{CS} \geq V_{DD} - 0.2V$ , CKE ≥ V <sub>IH</sub> (MIN) t <sub>CK</sub> = 15ns	65	65	65	mA
I <sub>DD3NS</sub>	Active Standby Current (In Non Power-Down Mode)	$\overline{CS} \geq V_{DD} - 0.2V$ , CKE ≥ V <sub>IH</sub> (MIN) or CKE ≤ V <sub>IL</sub> (MAX), All inputs stable	45	45	45	mA
I <sub>DD4</sub>	Operating Current	All banks active, BL = 4, CL = 3, t <sub>CK</sub> = t <sub>CK</sub> (min)	285	245	230	mA
I <sub>DD5</sub>	Auto-Refresh Current	t <sub>RC</sub> = t <sub>RC</sub> (min), t <sub>CLK</sub> = t <sub>CLK</sub> (min)	270	260	250	mA
I <sub>DD6</sub>	Self-Refresh Current	CKE ≤ 0.2V	6	6	6	mA

### Notes:

- I<sub>DD</sub> (MAX) is specified at the output open condition.
- Input signals are changed one time during 30ns.
- All values applicable for operation with T<sub>A</sub> ≤ 85°C.
- For A2 temperature grade with T<sub>A</sub> > 85°C: IDD1 is derated to 10% above the values.



# IS42/45R86400D/16320D/32160D, IS42/45S86400D/16320D/32160D

## AC ELECTRICAL CHARACTERISTICS <sup>(1,2,3)</sup>

Symbol	Parameter		-5		-6		-7		Units
			Min.	Max.	Min.	Max.	Min.	Max.	
tCK3	Clock Cycle Time	$\overline{\text{CAS}}$ Latency = 3	5	—	6	—	7	—	ns
tCK2		$\overline{\text{CAS}}$ Latency = 2	10	—	10	—	7.5	—	ns
tAC3	Access Time From CLK	$\overline{\text{CAS}}$ Latency = 3	—	5.0	—	5.4	—	5.4	ns
tAC2		$\overline{\text{CAS}}$ Latency = 2	—	6	—	6	—	5.4	ns
tCH	CLK HIGH Level Width		2	—	2.5	—	2.5	—	ns
tCL	CLK LOW Level Width		2	—	2.5	—	2.5	—	ns
tOH3	Output Data Hold Time	$\overline{\text{CAS}}$ Latency = 3	2.5	—	2.7	—	2.7	—	ns
tOH2		$\overline{\text{CAS}}$ Latency = 2	2.5	—	2.7	—	2.7	—	ns
tLZ	Output LOW Impedance Time		0	—	0	—	0	—	ns
tHZ3	Output HIGH Impedance Time		—	5	—	5.4	—	5.4	ns
tHZ2			—	6	—	6	—	5.4	ns
tDS	Input Data Setup Time <sup>(2)</sup>		1.8	—	1.5	—	1.5	—	ns
tDH	Input Data Hold Time <sup>(2)</sup>		0.8	—	0.8	—	0.8	—	ns
tAS	Address Setup Time <sup>(2)</sup>		1.5	—	1.5	—	1.5	—	ns
tAH	Address Hold Time <sup>(2)</sup>		0.8	—	0.8	—	0.8	—	ns
tCKS	CKE Setup Time <sup>(2)</sup>		1.5	—	1.5	—	1.5	—	ns
tCKH	CKE Hold Time <sup>(2)</sup>		0.8	—	0.8	—	0.8	—	ns
tCMS	Command Setup Time ( $\overline{\text{CS}}$ , $\overline{\text{RAS}}$ , $\overline{\text{CAS}}$ , $\overline{\text{WE}}$ , DQM) <sup>(2)</sup>		1.5	—	1.5	—	1.5	—	ns
tCMH	Command Hold Time ( $\overline{\text{CS}}$ , $\overline{\text{RAS}}$ , $\overline{\text{CAS}}$ , $\overline{\text{WE}}$ , DQM) <sup>(2)</sup>		0.8	—	0.8	—	0.8	—	ns
tRC	Command Period (REF to REF / ACT to ACT)		55	—	60	—	60	—	ns
tRAS	Command Period (ACT to PRE)		38	100K	42	100K	37	100K	ns
tRP	Command Period (PRE to ACT)		15	—	18	—	15	—	ns
tRCD	Active Command To Read / Write Command Delay Time		15	—	18	—	15	—	ns
tRRD	Command Period (ACT [0] to ACT[1])		10	—	12	—	14	—	ns
tdPL	Input Data To Precharge Command Delay time		10	—	12	—	14	—	ns
tdAL	Input Data To Active / Refresh Command Delay time (During Auto-Precharge)		25	—	30	—	29	—	ns
tMRD	Mode Register Program Time		10	—	12	—	14	—	ns
tdDE	Power Down Exit Setup Time		5	—	6	—	7	—	ns
txSR	Self-Refresh Exit Time		60	—	70	—	67	—	ns
tr	Transition Time		0.3	1.2	0.3	1.2	0.3	1.2	ns
tREF	Refresh Cycle Time (8192)	T <sub>A</sub> ≤ 70°C Com, Ind, A1, A2	—	64	—	64	—	64	ms
		T <sub>A</sub> ≤ 85°C Ind, A1, A2	—	64	—	64	—	64	ms
		T <sub>A</sub> > 85°C A2	—	—	—	—	—	16	ms

### Notes:

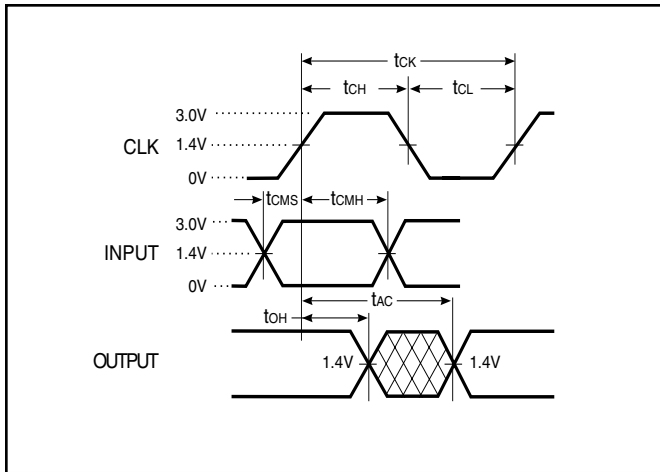
1. The power-on sequence must be executed before starting memory operation.
2. Measured with tr = 1 ns. If clock rising time is longer than 1ns, (tr / 2 - 0.5) ns should be added to the parameter.
3. The reference level is 1.4V when measuring input signal timing. Rise and fall times are measured between V<sub>IH</sub>(min.) and V<sub>IL</sub>(max).

## OPERATING FREQUENCY / LATENCY RELATIONSHIPS

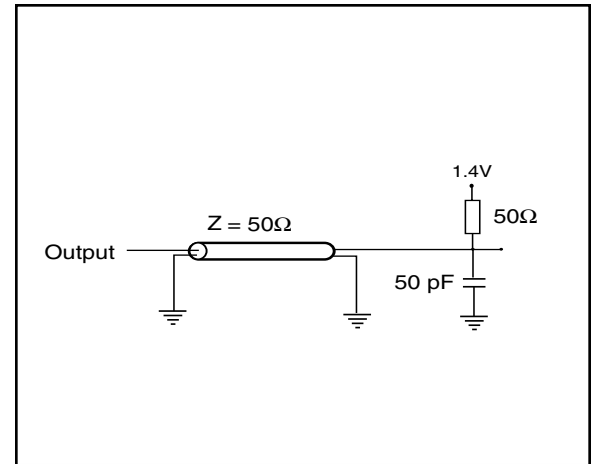
SYMBOL	PARAMETER	-5	-6	-7	-7	UNITS	
—	Clock Cycle Time	5	6	7	7.5	ns	
—	Operating Frequency	200	167	143	133	MHz	
t <sub>CAC</sub>	$\overline{\text{CAS}}$ Latency	3	3	3	2	cycle	
t <sub>RCD</sub>	Active Command To Read/Write Command Delay Time	3	3	3	2	cycle	
t <sub>RAC</sub>	$\overline{\text{RAS}}$ Latency (t <sub>RCD</sub> + t <sub>CAC</sub> )	$\overline{\text{CAS}}$ Latency = 3	6	6	6	—	cycle
		$\overline{\text{CAS}}$ Latency = 2	—	—	—	4	
t <sub>RC</sub>	Command Period (REF to REF / ACT to ACT)	10	10	9	8	cycle	
t <sub>RAS</sub>	Command Period (ACT to PRE)	7	7	6	5	cycle	
t <sub>RP</sub>	Command Period (PRE to ACT)	3	3	3	2	cycle	
t <sub>RRD</sub>	Command Period (ACT[0] to ACT [1])	2	2	2	2	cycle	
t <sub>CCD</sub>	Column Command Delay Time (READ, READA, WRIT, WRITA)	1	1	1	1	cycle	
t <sub>DPL</sub>	Input Data To Precharge Command Delay Time	2	2	2	2	cycle	
t <sub>DAL</sub>	Input Data To Active/Refresh Command Delay Time (During Auto-Precharge)	5	5	5	4	cycle	
t <sub>RGBD</sub>	Burst Stop Command To Output in HIGH-Z Delay Time (Read)	$\overline{\text{CAS}}$ Latency = 3	3	3	3	—	cycle
		$\overline{\text{CAS}}$ Latency = 2	—	—	—	2	
t <sub>WBD</sub>	Burst Stop Command To Input in Invalid Delay Time (Write)	0	0	0	0	cycle	
t <sub>RQL</sub>	Precharge Command To Output in HIGH-Z Delay Time (Read)	$\overline{\text{CAS}}$ Latency = 3	3	3	3	—	cycle
		$\overline{\text{CAS}}$ Latency = 2	—	—	—	2	
t <sub>WDL</sub>	Precharge Command To Input in Invalid Delay Time (Write)	0	0	0	0	cycle	
t <sub>PQL</sub>	Last Output To Auto-Precharge Start Time (Read)	$\overline{\text{CAS}}$ Latency = 3	-2	-2	-2	—	cycle
		$\overline{\text{CAS}}$ Latency = 2	—	—	—	-1	
t <sub>QMD</sub>	DQM To Output Delay Time (Read)	2	2	2	2	cycle	
t <sub>DMD</sub>	DQM To Input Delay Time (Write)	0	0	0	0	cycle	
t <sub>MRD</sub>	Mode Register Set To Command Delay Time	2	2	2	2	cycle	

**AC TEST CONDITIONS: 3.3V**

**Input Load**



**Output Load**

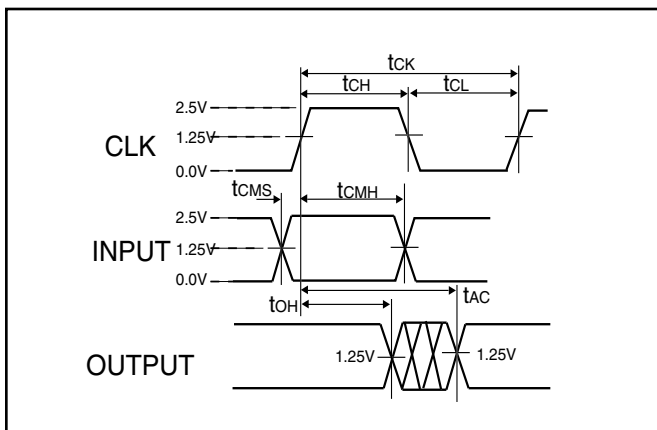


**AC TEST CONDITIONS**

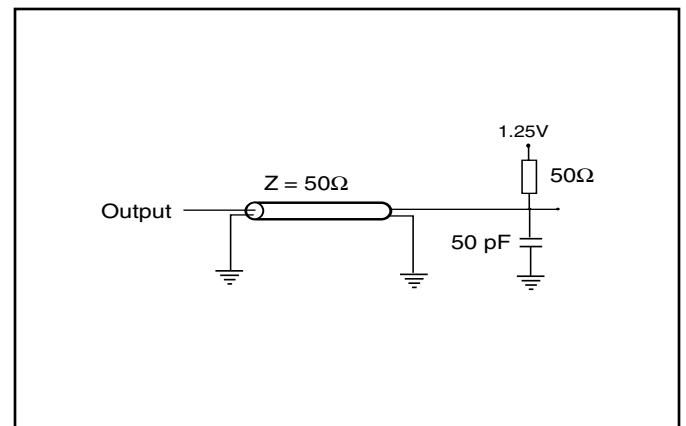
Parameter	IS42/45Sxxxxx Rating	IS42/45Rxxxxx Rating
AC Input Levels	0V to 3.0V	0V to 2.5V
Input Rise and Fall Times	1 ns	1 ns
Input Timing Reference Level	1.4V	1.25V
Output Timing Measurement Reference Level	1.4V	1.25V

**AC TEST CONDITIONS: 2.5V**

**Input Load**



**Output Load**



## **FUNCTIONAL DESCRIPTION**

The 512Mb SDRAMs are quad-bank DRAMs which operate at 3.3V or 2.5V and include a synchronous interface (all signals are registered on the positive edge of the clock signal, CLK).

Read and write accesses to the SDRAM are burst oriented; accesses start at a selected location and continue for a programmed number of locations in a programmed sequence. Accesses begin with the registration of an ACTIVE command which is then followed by a READ or WRITE command. The address bits registered coincident with the ACTIVE command are used to select the bank and row to be accessed (BA0 and BA1 select the bank, A0-A12 select the row). The address bits A0-An; registered coincident with the READ or WRITE command are used to select the starting column location for the burst access.

Prior to normal operation, the SDRAM must be initialized. The following sections provide detailed information covering device initialization, register definition, command descriptions and device operation.

## **Initialization**

SDRAMs must be powered up and initialized in a predefined manner.

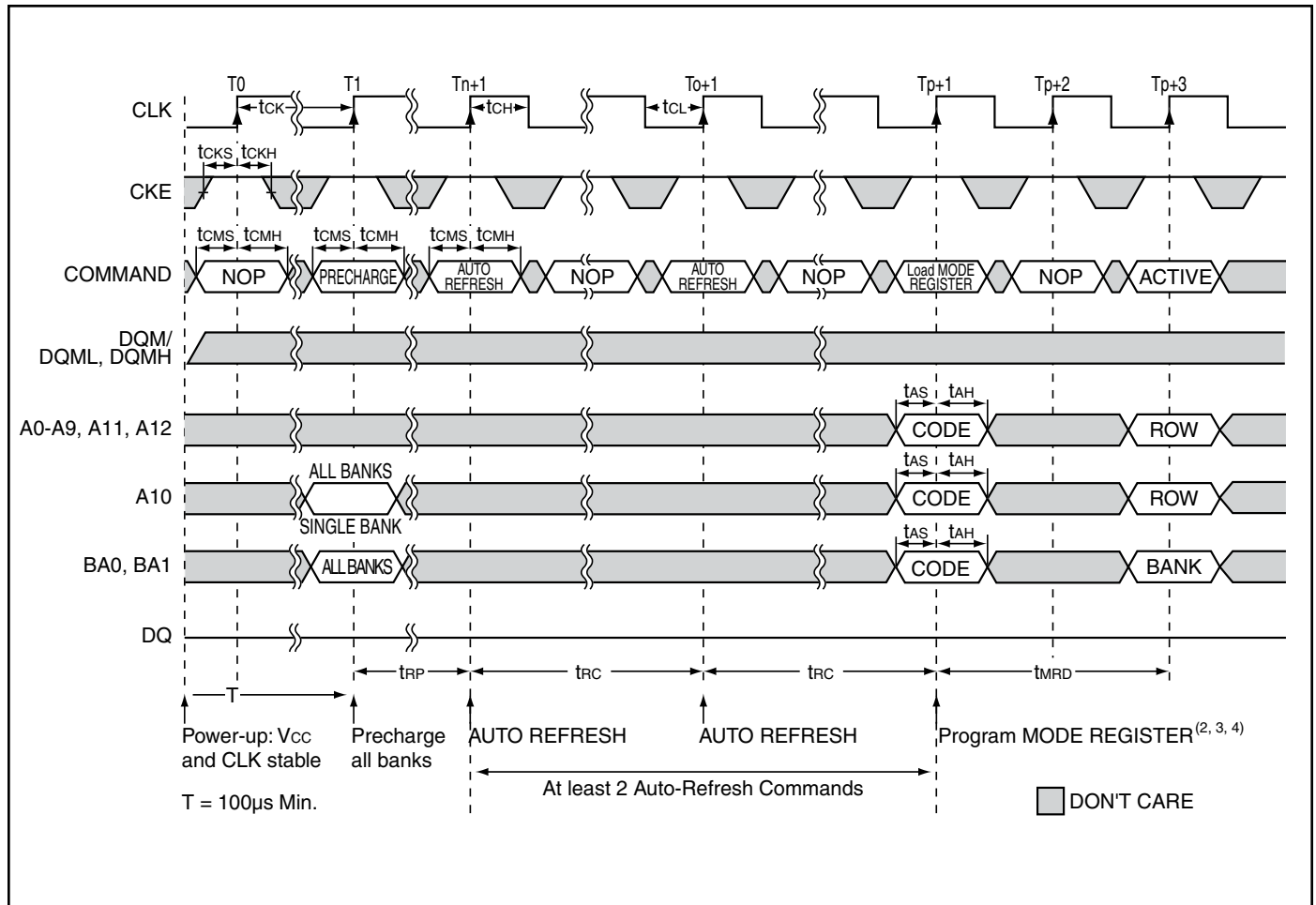
The 512Mb SDRAM is initialized after the power is applied to V<sub>DD</sub> and V<sub>DDQ</sub> (simultaneously) and the clock is stable with DQM High and CKE High.

A 100µs delay is required prior to issuing any command other than a COMMAND INHIBIT or a NOP. The COMMAND INHIBIT or NOP may be applied during the 100µs period and should continue at least through the end of the period.

With at least one COMMAND INHIBIT or NOP command having been applied, a PRECHARGE command should be applied once the 100µs delay has been satisfied. All banks must be precharged. This will leave all banks in an idle state after which at least two AUTO REFRESH cycles must be performed. After the AUTO REFRESH cycles are complete, the SDRAM is then ready for mode register programming.

The mode register should be loaded prior to applying any operational command because it will power up in an unknown state.

**INITIALIZE AND LOAD MODE REGISTER<sup>(1)</sup>**

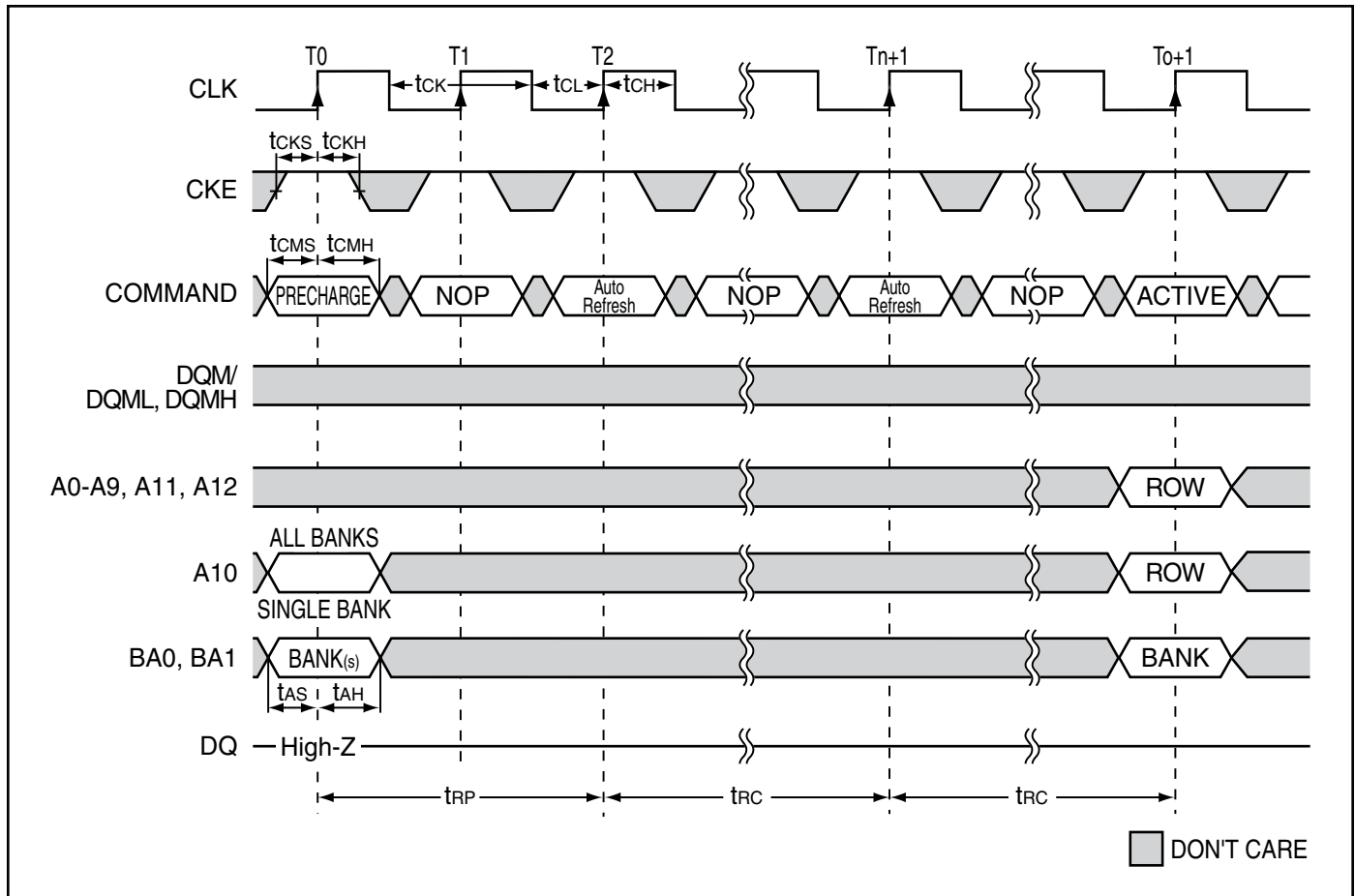


**Notes:**

1. If CS is High at clock High time, all commands applied are NOP.
2. The Mode register may be loaded prior to the Auto-Refresh cycles if desired.
3. JEDEC and PC100 specify three clocks.
4. Outputs are guaranteed High-Z after the command is issued.



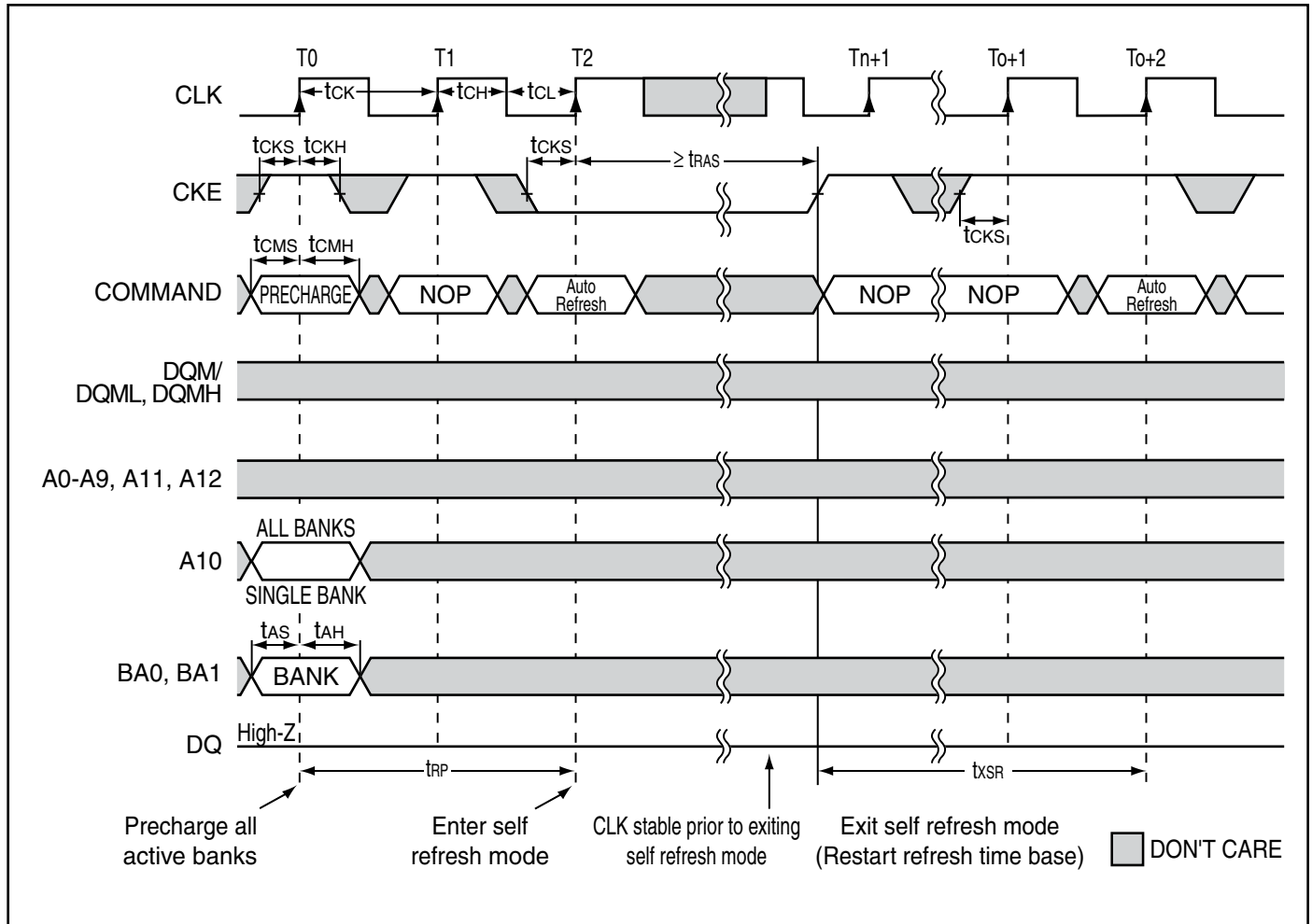
### AUTO-REFRESH CYCLE



**Notes:**

1.  $\overline{CAS}$  latency = 2, 3

### SELF-REFRESH CYCLE



**Notes:**

1. Self-Refresh mode is not supported for A2 grade with  $T_A > +85^\circ\text{C}$ .