

KM41C16000C, KM41V16000C**CMOS DRAM***16M x1Bit CMOS Dynamic RAM with Fast Page Mode***DESCRIPTION**

This is a family of 16,777,216 x 1 bit Fast Page Mode CMOS DRAMs. Fast Page Mode offers high speed random access of memory cells within the same row. Power supply voltage (+5.0V or +3.3V), access time (-5 or -6), power consumption(Normal or Low power) and package type(SOJ or TSOP-II) are optional features of this family. All of this family have $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh, $\overline{\text{RAS}}$ -only refresh and Hidden refresh capabilities. Furthermore, Self-refresh operation is available in L-version.

This 16Mx1 Fast Page Mode DRAM family is fabricated using Samsung's advanced CMOS process to realize high band-width, low power consumption and high reliability. It may be used as main memory unit for high level computer and microcomputer.

FEATURES**• Part Identification**

- KM41C16000C/C-L (5V, 4K Ref.)
- KM41V16000C/C-L (3.3V, 4K Ref.)

• Active Power Dissipation

Unit : mW

Speed	3.3V	5V
-5	324	495
-6	288	440

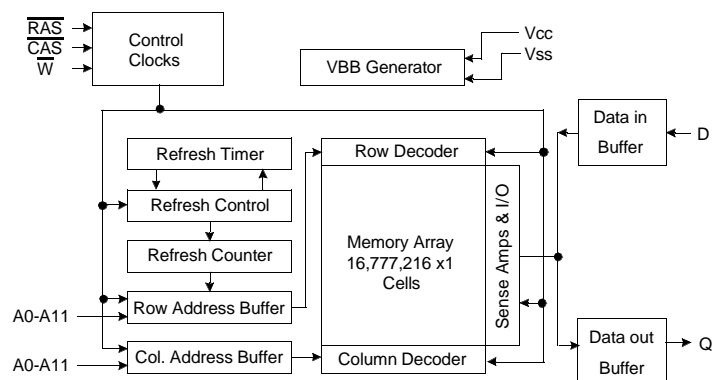
• Refresh Cycles

Part NO.	V _{CC}	Refresh cycle	Refresh period	
			Normal	L-ver
C16000C	5V	4K	64ms	128ms
V16000C	3.3V			

• Performance Range

Speed	t _{RAC}	t _{CAC}	t _{RC}	t _{PC}	Remark
-5	50ns	13ns	90ns	35ns	5V/3.3V
-6	60ns	15ns	110ns	40ns	5V/3.3V

- Fast Page Mode operation
- $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh capability
- $\overline{\text{RAS}}$ -only and Hidden refresh capability
- Self-refresh capability (L-ver only)
- Fast Parallel test mode capability
- TTL(5V)/LVTTTL(3.3V) compatible inputs and outputs
- Early Write Operation
- JEDEC Standard pinout
- Available in Plastic SOJ and TSOP(II) packages
- Single +5V±10% power supply (5V product)
- Single +3.3V±0.3V power supply (3.3V product)

FUNCTIONAL BLOCK DIAGRAM

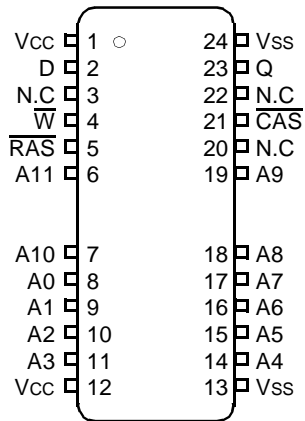
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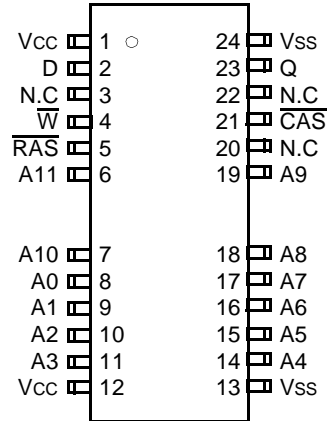
CMOS DRAM

PIN CONFIGURATION (Top Views)

• KM41C/V1600CK



• KM41C/V1600CS



K:300mil 26(24) SOJ
S:300mil 26(24) TSOP II

Pin Name	Pin Function
A0 - A11	Address Inputs (4K Product)
D	Data In
Q	Data Out
Vss	Ground
\overline{RAS}	Row Address Strobe
\overline{CAS}	Column Address Strobe
\overline{W}	Read/Write Input
Vcc	Power(+5.0V)
	Power(+3.3V)
N.C	No Connection

KM41C1600C, KM41V1600C**CMOS DRAM****ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Rating		Units
		3.3V	5V	
Voltage on any pin relative to Vss	V _{IN} , V _{OUT}	-0.5 to +4.6	-1.0 to +7.0	V
Voltage on Vcc supply relative to Vss	V _{CC}	-0.5 to +4.6	-1.0 to +7.0	V
Storage Temperature	T _{stg}	-55 to +150	-55 to +150	°C
Power Dissipation	P _D	1	1	W
Short Circuit Output Current	I _{os}	50	50	mA

* Permanent device damage may occur if "ABSOLUTE MAXIMUM RATINGS" are exceeded. Functional operation should be restricted to the conditions as detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING CONDITIONS (Voltage referenced to Vss, T_A = 0 to 70°C)

Parameter	Symbol	3.3V			5V			Units
		Min	Typ	Max	Min	Typ	Max	
Supply Voltage	V _{CC}	3.0	3.3	3.6	4.5	5.0	5.5	V
Ground	V _{SS}	0	0	0	0	0	0	V
Input High Voltage	V _{IH}	2.0	-	V _{CC} +0.3* ¹	2.4	-	V _{CC} +1.0* ¹	V
Input Low Voltage	V _{IL}	-0.3* ²	-	0.8	-1.0* ²	-	0.8	V

*1 : V_{CC}+1.3V/15ns(3.3V), V_{CC}+2.0/20ns(5V), Pulse width is measured at V_{CC}

*2 : -1.3V/15ns(3.3V), -2.0/20ns(5V), Pulse width is measured at V_{SS}

DC AND OPERATING CHARACTERISTICS (Recommended operating conditions unless otherwise noted.)

Max	Parameter	Symbol	Min	Max	Units
3.3V	Input Leakage Current (Any input 0 ≤ V _{IN} ≤ V _{IN} +0.3V, all other input pins not under test=0 Volt)	I _{I(L)}	-5	5	uA
	Output Leakage Current (Data out is disabled, 0V ≤ V _{OUT} ≤ V _{CC})	I _{O(L)}	-5	5	uA
	Output High Voltage Level(I _{OH} =-2mA)	V _{OH}	2.4	-	V
	Output Low Voltage Level(I _{OL} =2mA)	V _{OL}	-	0.4	V
5V	Input Leakage Current (Any input 0 ≤ V _{IN} ≤ V _{IN} +0.5V, all other input pins not under test=0 Volt)	I _{I(L)}	-5	5	uA
	Output Leakage Current (Data out is disabled, 0V ≤ V _{OUT} ≤ V _{CC})	I _{O(L)}	-5	5	uA
	Output High Voltage Level(I _{OH} =-5mA)	V _{OH}	2.4	-	V
	Output Low Voltage Level(I _{OL} =4.2mA)	V _{OL}	-	0.4	V



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KM41C1600C, KM41V1600C**CMOS DRAM****DC AND OPERATING CHARACTERISTICS** (Continued)

Symbol	Power	Speed	Max		Units
			KM41V1600C	KM41C1600C	
I _{CC1}	Don't care	-5 -6	90	90	mA
			80	80	mA
I _{CC2}	Normal L	Don't care	1	2	mA
			1	1	mA
I _{CC3}	Don't care	-5 -6	90	100	mA
			80	90	mA
I _{CC4}	Don't care	-5 -6	90	90	mA
			80	80	mA
I _{CC5}	Normal L	Don't care	0.5	1	mA
			200	250	uA
I _{CC6}	Don't care	-5 -6	90	100	mA
			80	90	mA
I _{CC7}	L	Don't care	200	300	uA
I _{CCS}	L	Don't care	150	250	uA

I_{CC1}* : Operating Current (\overline{RAS} and \overline{CAS} cycling @t_{RC}=min.)

I_{CC2} : Standby Current ($\overline{RAS}=\overline{CAS}=\overline{W}=V_{IH}$)

I_{CC3}* : \overline{RAS} -only Refresh Current ($\overline{CAS}=V_{IH}$, \overline{RAS} cycling @t_{RC}=min.)

I_{CC4}* : Fast Page Mode Current ($\overline{RAS}=V_{IL}$, \overline{CAS} , Address cycling @t_{PC}=min.)

I_{CC5} : Standby Current ($\overline{RAS}=\overline{CAS}=\overline{W}=V_{CC}-0.2V$)

I_{CC6}* : \overline{CAS} -Before- \overline{RAS} Refresh Current (\overline{RAS} and \overline{CAS} cycling @t_{RC}=min.)

I_{CC7} : Battery back-up current, Average power supply current, Battery back-up mode

Input high voltage(V_{IH})=V_{CC}-0.2V, Input low voltage(V_{IL})=0.2V, $\overline{CAS}=0.2V$,

DQ=Don't care, T_{RC}=31.25us(L-ver), T_{RAS}=T_{RASmin}~300ns

I_{CCS} : Self Refresh Current

$\overline{RAS}=\overline{CAS}=0.2V$, $\overline{W}=A0 \sim A11=V_{CC}-0.2V$ or 0.2V,

D, Q=V_{CC}-0.2V, 0.2V or Open

***Note :** I_{CC1}, I_{CC3}, I_{CC4} and I_{CC6} are dependent on output loading and cycle rates. Specified values are obtained with the output open. I_{CC} is specified as an average current. In I_{CC1}, I_{CC3} and I_{CC6} address can be changed maximum once while $\overline{RAS}=V_{IL}$. In I_{CC4}, address can be changed maximum once within one fast page mode cycle time, t_{PC}.

KM41C1600C, KM41V1600C**CMOS DRAM****CAPACITANCE** ($T_A=25^\circ\text{C}$, $V_{CC}=5\text{V}$ or 3.3V , $f=1\text{MHz}$)

Parameter	Symbol	Min	Max	Units
Input capacitance [D]	C _{IN1}	-	7	pF
Input capacitance [A0 ~ A11]	C _{IN2}	-	5	pF
Input capacitance [$\overline{\text{RAS}}$, $\overline{\text{CAS}}$, $\overline{\text{W}}$, $\overline{\text{OE}}$]	C _{IN3}	-	7	pF
Output capacitance [Q]	C _{OUT}	-	7	pF

AC CHARACTERISTICS ($0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$, See note 1,2)Test condition (5V device) : $V_{CC}=5.0\text{V} \pm 10\%$, $V_{ih}/V_{il}=2.4/0.8\text{V}$, $V_{oh}/V_{ol}=2.4/0.4\text{V}$ Test condition (3.3V device) : $V_{CC}=3.3\text{V} \pm 0.3\text{V}$, $V_{ih}/V_{il}=2.0/0.8\text{V}$, $V_{oh}/V_{ol}=2.0/0.8\text{V}$

Parameter	Symbol	-5		-6		Units	Notes
		Min	Max	Min	Max		
Random read or write cycle time	trc	90		110		ns	
Read-modify-write cycle time	trwc	110		130		ns	
Access time from $\overline{\text{RAS}}$	trac		50		60	ns	3,4,10
Access time from $\overline{\text{CAS}}$	tcac		13		15	ns	3,5
Access time from column address	t _{AA}		25		30	ns	3,10
$\overline{\text{CAS}}$ to output in Low-Z	tclz	0		0		ns	3
Output buffer turn-off delay	t _{OFF}	0	13	0	15	ns	6
Transition time (rise and fall)	t _T	3	50	3	50	ns	2
$\overline{\text{RAS}}$ precharge time	trp	30		40		ns	
$\overline{\text{RAS}}$ pulse width	tr _{AS}	50	10K	60	10K	ns	
$\overline{\text{RAS}}$ hold time	tr _{SH}	13		15		ns	
$\overline{\text{CAS}}$ hold time	tc _{SH}	50		60		ns	
$\overline{\text{CAS}}$ pulse width	tc _{AS}	13	10K	15	10K	ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ delay time	tr _{CD}	20	37	20	45	ns	4
$\overline{\text{RAS}}$ to column address delay time	tr _{AD}	15	25	15	30	ns	10
$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ precharge time	tc _{RP}	5		5		ns	
Row address set-up time	t _{ASR}	0		0		ns	
Row address hold time	tr _{AH}	10		10		ns	
Column address set-up time	t _{ASC}	0		0		ns	
Column address hold time	tc _{AH}	10		10		ns	
Column address to $\overline{\text{RAS}}$ lead time	tr _{AL}	25		30		ns	
Read command set-up time	tr _{CS}	0		0		ns	
Read command hold time referenced to $\overline{\text{CAS}}$	tr _{CH}	0		0		ns	8
Read command hold time referenced to $\overline{\text{RAS}}$	tr _{RH}	0		0		ns	8
Write command hold time	tw _{CH}	10		10		ns	
Write command pulse width	tw _P	10		10		ns	
Write command to $\overline{\text{RAS}}$ lead time	tr _{WL}	13		15		ns	
Write command to $\overline{\text{CAS}}$ lead time	tc _{WL}	13		15		ns	

KM41C1600C, KM41V1600C**CMOS DRAM****AC CHARACTERISTICS** (Continued)

Parameter	Symbol	-5		-6		Units	Notes
		Min	Max	Min	Max		
Data set-up time	tDS	0		0		ns	9
Data hold time	tDH	10		10		ns	9
Refresh period (Normal)	tREF		64		64	ms	
Refresh period (L-ver)	tREF		128		128	ms	
Write command set-up time	tWCS	0		0		ns	7
$\overline{\text{CAS}}$ to $\overline{\text{W}}$ delay time	tCWD	13		15		ns	7
$\overline{\text{RAS}}$ to $\overline{\text{W}}$ delay time	tRWD	50		60		ns	7
Column address to $\overline{\text{W}}$ delay time	tAWD	25		30		ns	7
$\overline{\text{CAS}}$ precharge to $\overline{\text{W}}$ delay time	tCPWD	30		35		ns	
$\overline{\text{CAS}}$ set-up time ($\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh)	tCSR	5		5		ns	
$\overline{\text{CAS}}$ hold time ($\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh)	tCHR	10		10		ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ precharge time	tRPC	5		5		ns	
Access time from $\overline{\text{CAS}}$ precharge	tCPA		30		35	ns	3
Fast Page mode cycle time	tPC	35		40		ns	
Fast Page read-modify-write cycle time	tPRWC	53		60		ns	
$\overline{\text{CAS}}$ precharge time (Fast Page cycle)	tCP	10		10		ns	
$\overline{\text{RAS}}$ pulse width (Fast Page cycle)	tRASP	50	200K	60	200K	ns	
$\overline{\text{RAS}}$ hold time from $\overline{\text{CAS}}$ precharge	tRHCP	30		35		ns	
Write command set-up time (Test mode in)	tWTS	10		10		ns	11
Write command hold time (Test mode in)	tWTH	10		10		ns	11
$\overline{\text{W}}$ to $\overline{\text{RAS}}$ precharge time ($\overline{\text{C}}$ - $\overline{\text{B}}$ - $\overline{\text{R}}$ refresh)	tWRP	10		10		ns	
$\overline{\text{W}}$ to $\overline{\text{RAS}}$ hold time ($\overline{\text{C}}$ - $\overline{\text{B}}$ - $\overline{\text{R}}$ refresh)	tWRH	10		10		ns	
$\overline{\text{RAS}}$ pulse width ($\overline{\text{C}}$ - $\overline{\text{B}}$ - $\overline{\text{R}}$ self refresh)	tRASS	100		100		us	13,14,15
$\overline{\text{RAS}}$ precharge time ($\overline{\text{C}}$ - $\overline{\text{B}}$ - $\overline{\text{R}}$ self refresh)	tRPS	90		110		ns	13,14,15
$\overline{\text{CAS}}$ hold time ($\overline{\text{C}}$ - $\overline{\text{B}}$ - $\overline{\text{R}}$ self refresh)	tCHS	-50		-50		ns	13,14,15

KM41C1600C, KM41V1600C**CMOS DRAM****TEST MODE CYCLE****(Note 11)**

Parameter	Symbol	-5		-6		Units	Notes
		Min	Max	Min	Max		
Random read or write cycle time	t _{RC}	95		115		ns	
Read-modify-write cycle time	t _{RWC}	115		135		ns	
Access time from $\overline{\text{RAS}}$	t _{RAC}		55		65	ns	3,4,10,12
Access time from $\overline{\text{CAS}}$	t _{CAC}		18		20	ns	3,5,12
Access time from column address	t _{AA}		30		35	ns	3,10,12
$\overline{\text{RAS}}$ pulse width	t _{RAS}	55	10K	65	10K	ns	
$\overline{\text{CAS}}$ pulse width	t _{CAS}	18	10K	20	10K	ns	
$\overline{\text{RAS}}$ hold time	t _{RSH}	18		20		ns	
$\overline{\text{CAS}}$ hold time	t _{CSH}	55		65		ns	
Column address to $\overline{\text{RAS}}$ lead time	t _{RAL}	30		35		ns	
$\overline{\text{CAS}}$ to $\overline{\text{W}}$ delay time	t _{CWD}	18		20		ns	7
$\overline{\text{RAS}}$ to $\overline{\text{W}}$ delay time	t _{RWD}	55		65		ns	7
Column address to $\overline{\text{W}}$ delay time	t _{AWD}	30		35		ns	7
$\overline{\text{CAS}}$ precharge to $\overline{\text{W}}$ delay time	t _{CPWD}	35		40		ns	
Fast Page mode cycle time	t _{PC}	40		45		ns	
Fast Page read-modify-write cycle time	t _{PRWC}	58		65		ns	
$\overline{\text{RAS}}$ pulse width (Fast Page cycle)	t _{RASP}	55	200K	65	200K	ns	
Access time from $\overline{\text{CAS}}$ precharge	t _{CPA}		35		40	ns	3



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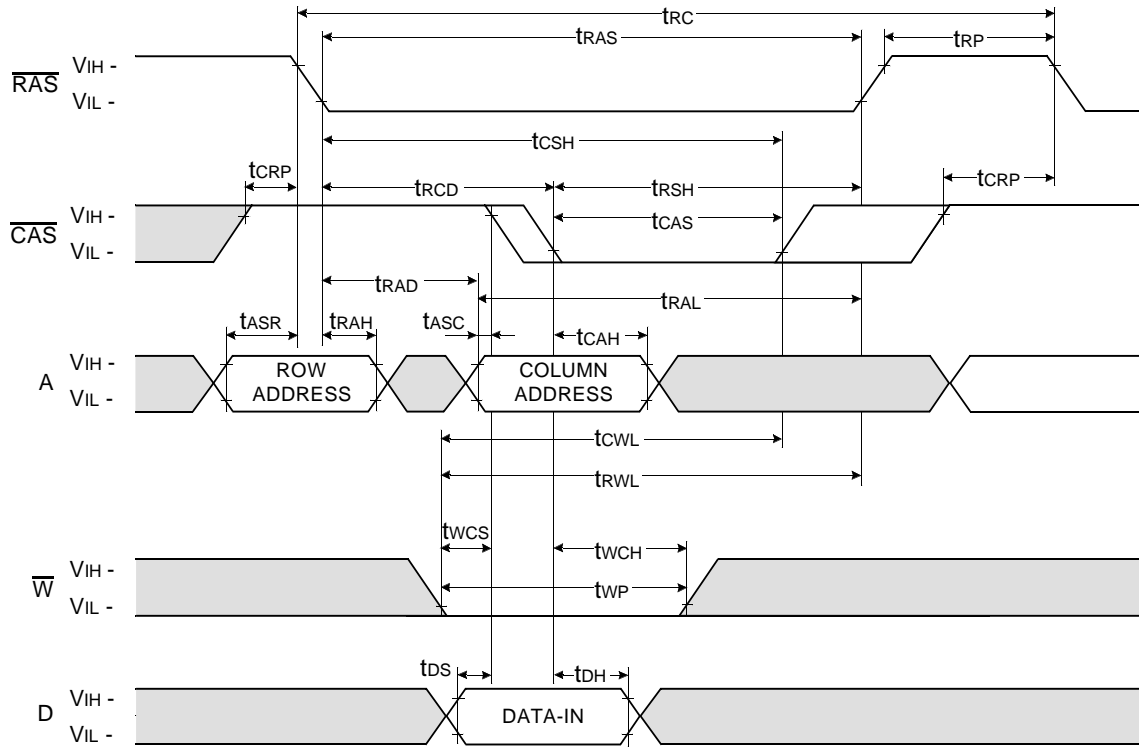
KM41C1600C, KM41V1600C**CMOS DRAM****NOTES**

1. An initial pause of 200us is required after power-up followed by any 8 $\overline{\text{RAS}}$ -only refresh or $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh cycles before proper device operation is achieved.
2. $V_{IH}(\text{min})$ and $V_{IL}(\text{max})$ are reference levels for measuring timing of input signals. Transition times are measured between $V_{IH}(\text{min})$ and $V_{IL}(\text{max})$ and are assumed to be 5ns for all inputs.
3. Measured with a load equivalent to 2 TTL(5V)/1 TTL(3.3V) loads and 100pF.
4. Operation within the $t_{\text{RCD}}(\text{max})$ limit insures that $t_{\text{RAC}}(\text{max})$ can be met. $t_{\text{RCD}}(\text{max})$ is specified as a reference point only. If t_{RCD} is greater than the specified $t_{\text{RCD}}(\text{max})$ limit, then access time is controlled exclusively by t_{CAC} .
5. Assumes that $t_{\text{RCD}} \geq t_{\text{RCD}}(\text{max})$.
6. $t_{\text{OFF}}(\text{min})$ and $t_{\text{OEZ}}(\text{max})$ define the time at which the output achieves the open circuit condition and are not referenced V_{OH} or V_{OL} .
7. t_{WCS} , t_{RWD} , t_{CWD} and t_{AWD} are non restrictive operating parameters. They are included in the data sheet as electrical characteristics only. If $t_{\text{WCS}} \geq t_{\text{WCS}}(\text{min})$, the cycle is an early write cycle and the data output will remain high impedance for the duration of the cycle. If $t_{\text{CWD}} \geq t_{\text{CWD}}(\text{min})$, $t_{\text{RWD}} \geq t_{\text{RWD}}(\text{min})$ and $t_{\text{AWD}} \geq t_{\text{AWD}}(\text{min})$, then the cycle is a read-modify-write cycle and the data output will contain the data read from the selected address. If neither of the above conditions is satisfied, the condition of the data out is indeterminate.
8. Either t_{RCH} or t_{RRH} must be satisfied for a read cycle.
9. These parameters are referenced to $\overline{\text{CAS}}$ falling edge in early write cycles and to $\overline{\text{W}}$ falling edge in read-modify-write cycles.
10. Operation within the $t_{\text{RAD}}(\text{max})$ limit insures that $t_{\text{RAC}}(\text{max})$ can be met. $t_{\text{RAD}}(\text{max})$ is specified as a reference point only. If t_{RAD} is greater than the specified $t_{\text{RAD}}(\text{max})$ limit, then access time is controlled by t_{AA} .
11. These specifications are applied in the test mode.
12. In test mode read cycle, the value of t_{RAC} , t_{AA} , t_{CAC} is delayed by 2ns to 5ns for the specified values. These parameters should be specified in test mode cycles by adding the above value to the specified value in this data sheet.
13. If $t_{\text{RASS}} \geq 100\text{us}$, then $\overline{\text{RAS}}$ precharge time must use t_{RPS} instead of t_{RP} .
14. For $\overline{\text{RAS}}$ -only refresh and burst $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh mode, 4096(4K) cycles of burst refresh must be executed within 64ms before and after self refresh, in order to meet refresh specification.
15. For distributed $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ with 15.6us interval $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh should be executed with in 15.6us immediately before and after self refresh in order to meet refresh specification.

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WRITE CYCLE (EARLY WRITE)

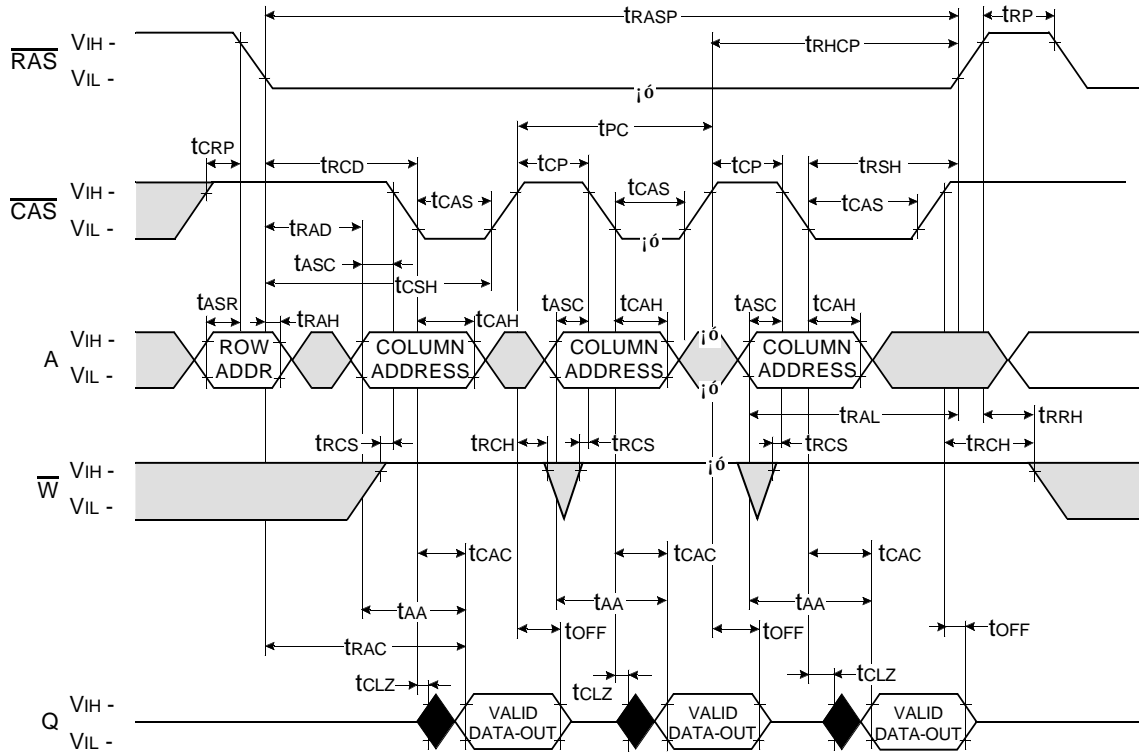


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CMOS DRAM

FAST PAGE READ CYCLE

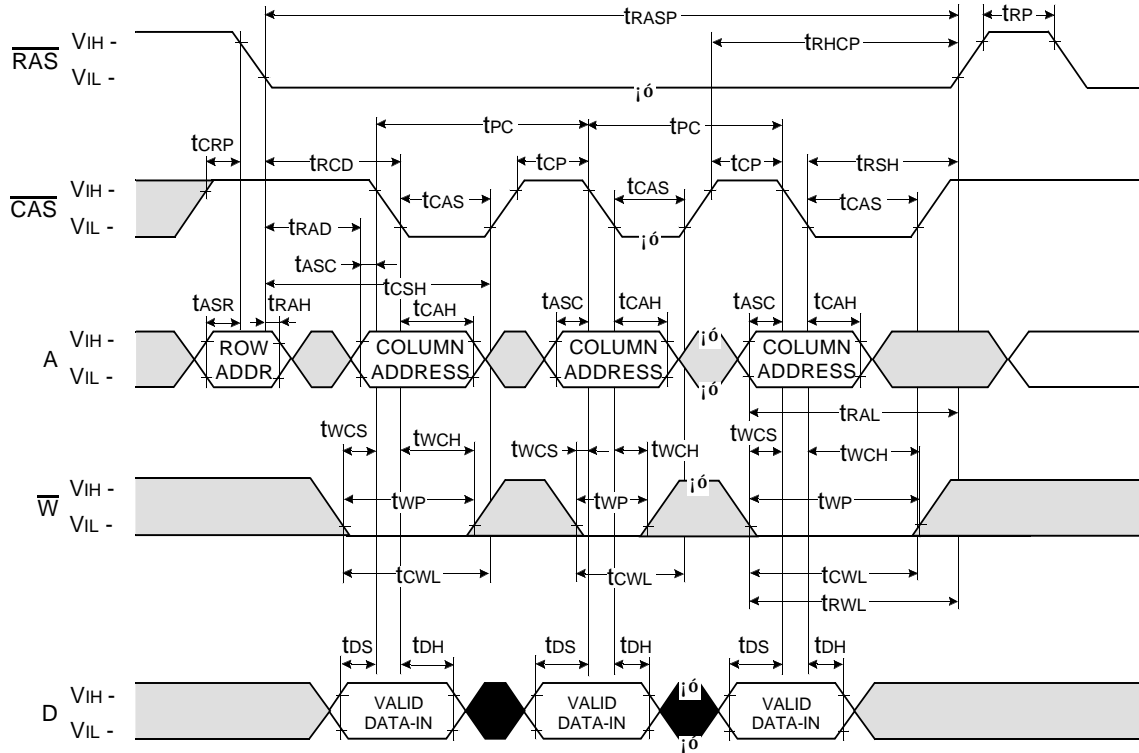


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CMOS DRAM

FAST PAGE WRITE CYCLE (EARLY WRITE)

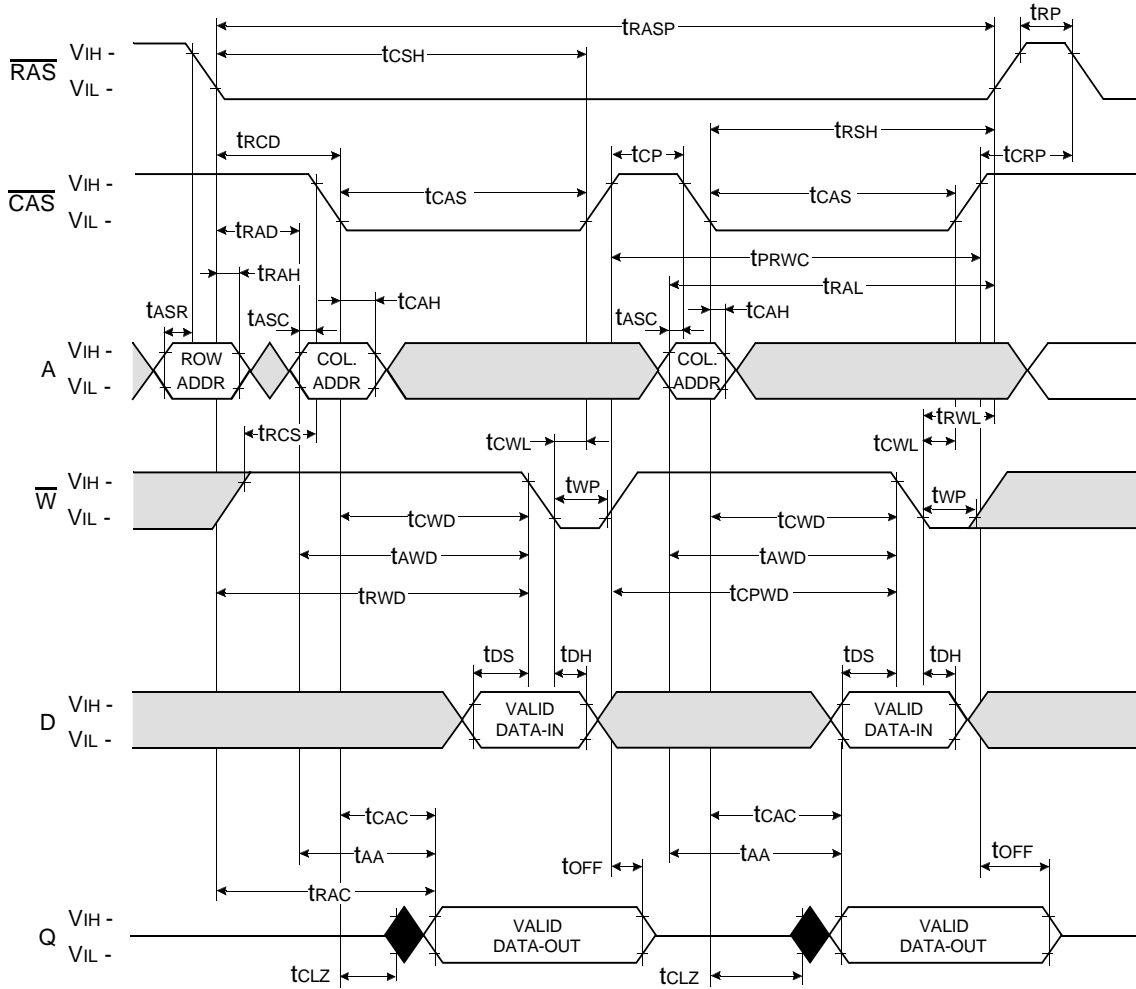


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KM41C1600C, KM41V1600C

CMOS DRAM

FAST PAGE READ - MODIFY - WRITE CYCLE



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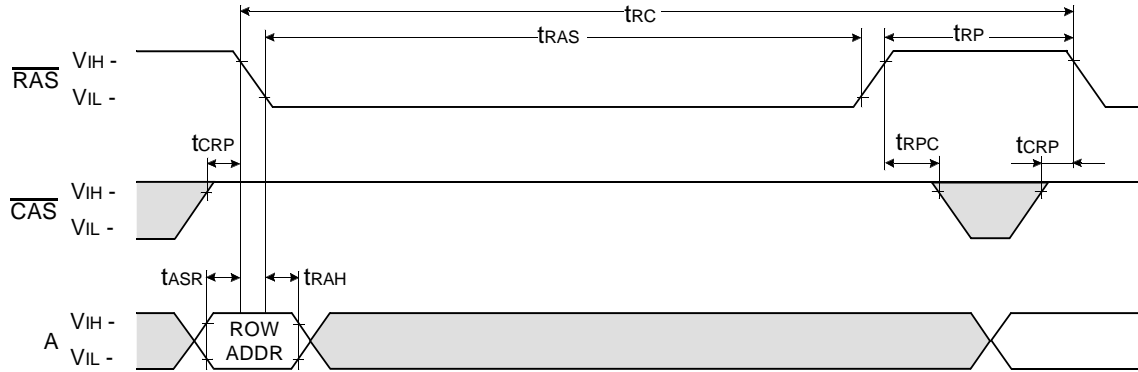
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CMOS DRAM

$\overline{\text{RAS}}$ - ONLY REFRESH CYCLE

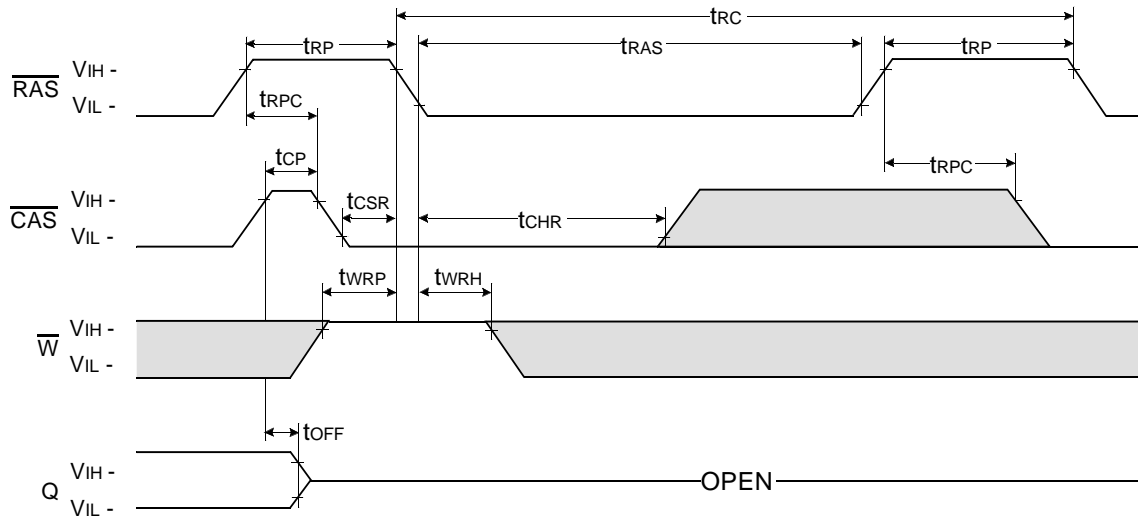
NOTE : $\overline{\text{W}}$, DIN = Don't care

DOUT = OPEN



$\overline{\text{CAS}}$ - BEFORE - $\overline{\text{RAS}}$ REFRESH CYCLE

NOTE : A = Don't care



Don't care
 Undefined

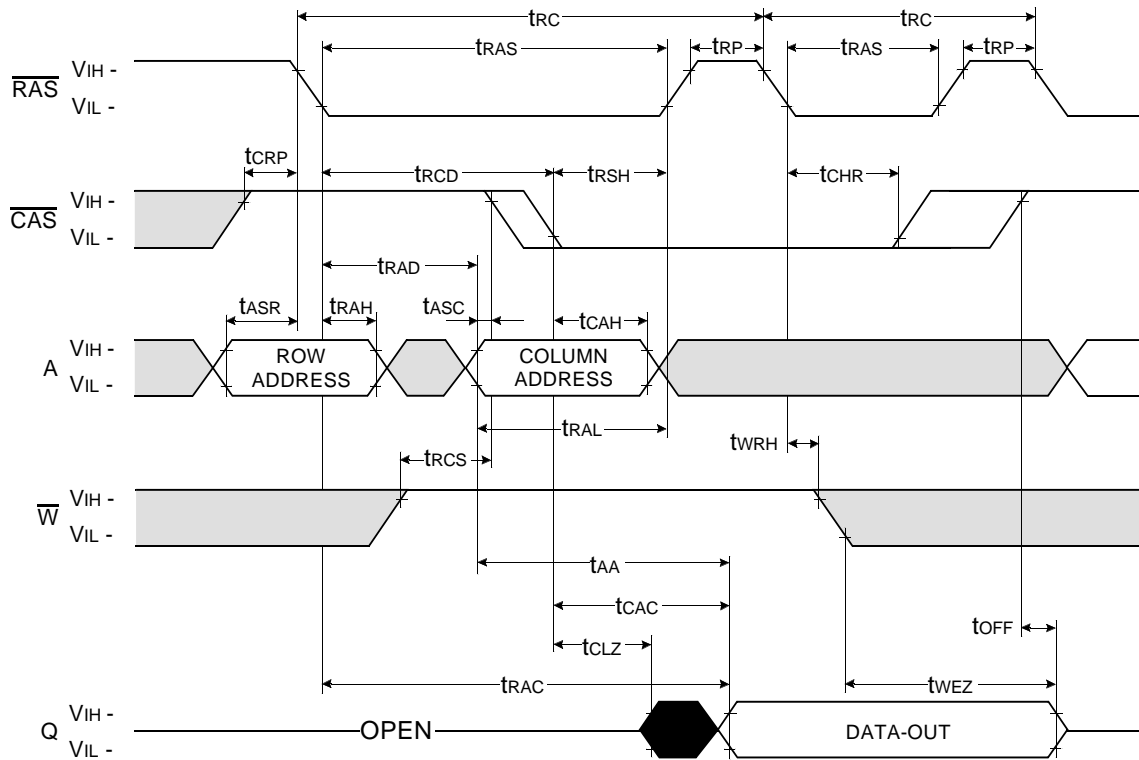


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HIDDEN REFRESH CYCLE (READ)

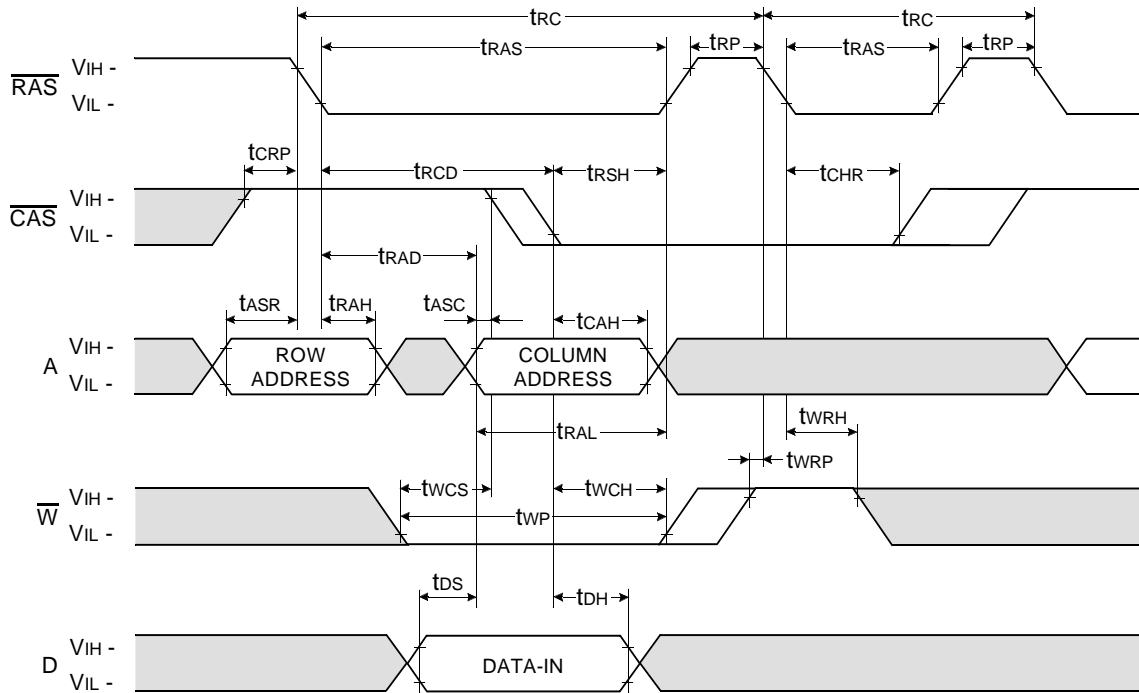


KM41C1600C, KM41V1600C

CMOS DRAM

HIDDEN REFRESH CYCLE (WRITE)

NOTE : DOUT = OPEN



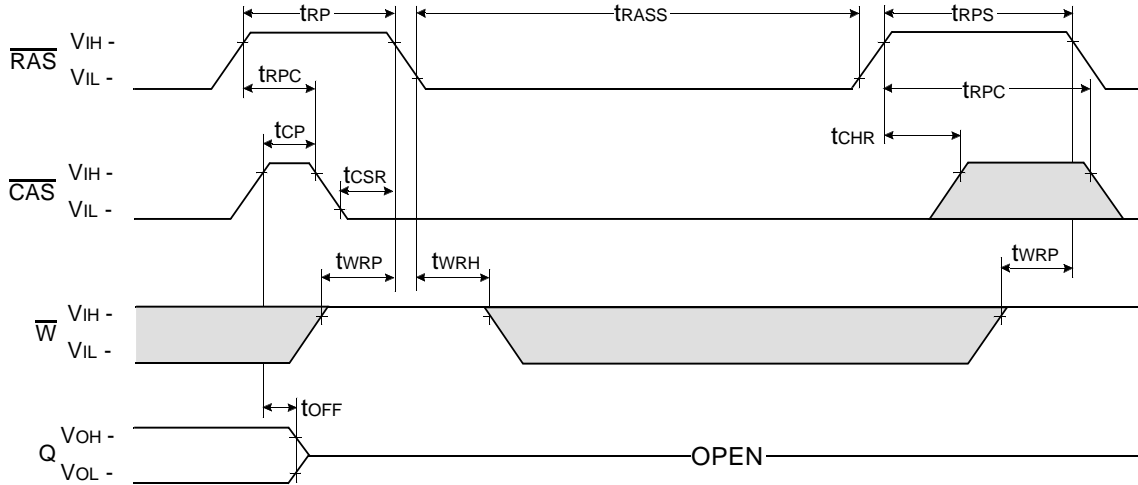
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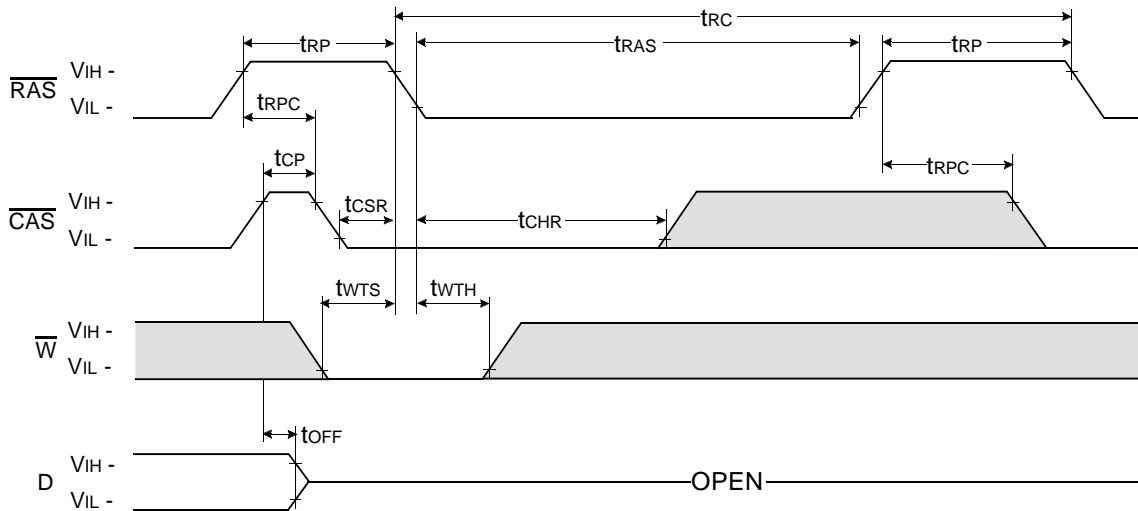
$\overline{\text{CAS}}$ - BEFORE - $\overline{\text{RAS}}$ SELF REFRESH CYCLE

NOTE : A = Don't care



TEST MODE IN CYCLE

NOTE : D, A = Don't care



Don't care
 Undefined

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PACKAGE DIMENSION

