

## 256K x 16Bit CMOS Dynamic RAM with Fast Page Mode

### DESCRIPTION

This is a family of 262,144 x 16 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,-6,-7), 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 256Kx16 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 graphic memory unit for microcomputer, personal computer and portable machines.

### FEATURES

#### Part Identification

- KM416C256D/DL (5V, 512K Ref.)
- KM416V256D/DL (3.3V, 512K Ref.)

#### Active Power Dissipation

Unit : mW

Speed	3.3V(512 Ref.)	5V(512 Ref.)
-5	-	605
-6	325	495
-7	290	440

#### Refresh Cycles

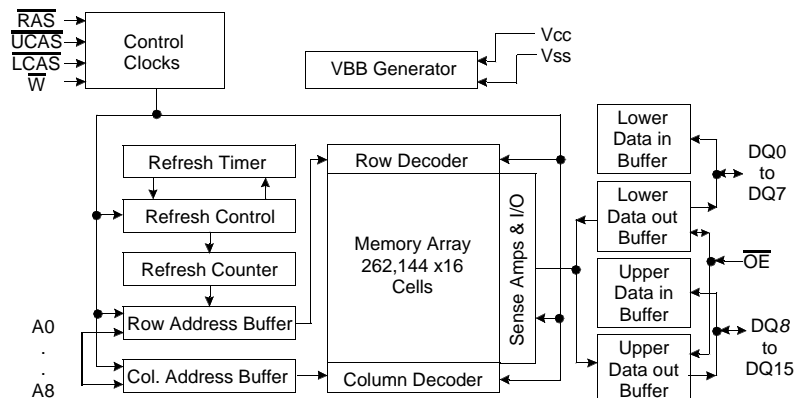
Part NO.	V <sub>CC</sub>	Refresh cycle	Refresh period	
			Normal	L-ver
C256D	5V	512K	8ms	128ms
V256D	3.3V			

#### Performance Range:

Speed	t <sub>RAC</sub>	t <sub>CAC</sub>	t <sub>RC</sub>	t <sub>PC</sub>	Remark
-5	50ns	15ns	90ns	35ns	5V only
-6	60ns	15ns	10ns	40ns	5V/3.3V
-7	70ns	20ns	130ns	45ns	5V/3.3V

- Fast Page Mode operation
- 2  $\overline{\text{CAS}}$  Byte/Wrod Read/Write operation
- $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  refresh capability
- $\overline{\text{RAS}}$ -only and Hidden refresh capability
- Self-refresh capability (L-ver only)
- TTL(5V)/LVTTTL(3.3V) compatible inputs and outputs
- Early Write or output enable controlled write
- JEDEC Standard pinout
- Available in 40-pin SOJ 400mil and 44(40)-pin TSOP(II) 400mil packages
- Triple +5V  $\pm$ 10% power supply(5V product)
- Triple +3.3V  $\pm$ 0.3V power supply(3.3V product)

### FUNCTIONAL BLOCK DIAGRAM

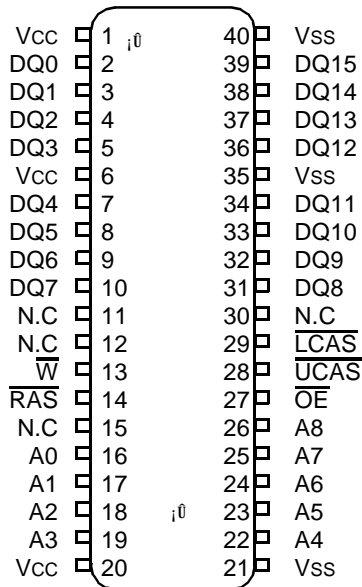


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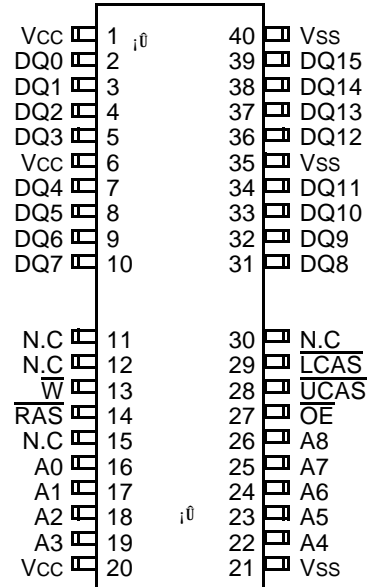
PIN CONFIGURATION (Top Views)

⊕ KM416C/V256DJ



(SOJ)

⊕ KM416C/V256DT



(TSOP-II)

Pin Name	Pin Function
A0 - A8	Address Inputs
DQ0 - 15	Data In/Out
Vss	Ground
$\overline{\text{RAS}}$	Row Address Strobe
$\overline{\text{UCAS}}$	Upper Column Address Strobe
$\overline{\text{LCAS}}$	Lower Column Address Strobe
$\overline{\text{W}}$	Read/Write Input
$\overline{\text{OE}}$	Data Output Enable
Vcc	Power(+5V)
	Power(+3.3V)
N.C	No Connection

## ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating		Units
		3.3V	5V	
Voltage on any pin relative to Vss	V <sub>IN</sub> , V <sub>OUT</sub>	-0.5 to +4.6	-1.0 to +7.0	V
Voltage on Vcc supply relative to Vss	V <sub>CC</sub>	-0.5 to +4.6	-1.0 to +7.0	V
Storage Temperature	T <sub>stg</sub>	-55 to +150	-55 to +150	°C
Power Dissipation	P <sub>D</sub>	1	1	W
Short Circuit Output Current	I <sub>OS</sub>	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<sub>A</sub>= 0 to 70°C)

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

\*1 : V<sub>CC</sub>+1.3V/15ns(3.3V), V<sub>CC</sub>+2.0V/20ns(5V), Pulse width is measured at V<sub>CC</sub>

\*2 : -1.3V/15ns(3.3V), -2.0V/20ns(5V), Pulse width is measured at V<sub>SS</sub>

## 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 <sub>IN</sub> ≤ V <sub>IN</sub> +0.3V, all other input pins not under test=0 Volt)	I <sub>I(L)</sub>	-5	5	μA
	Output Leakage Current (Data out is disabled, 0V ≤ V <sub>OUT</sub> ≤ V <sub>CC</sub> )	I <sub>O(L)</sub>	-5	5	μA
	Output High Voltage Level(I <sub>OH</sub> =-2mA)	V <sub>OH</sub>	2.4	-	V
	Output Low Voltage Level(I <sub>OL</sub> =2mA)	V <sub>OL</sub>	-	0.4	V
5V	Input Leakage Current (Any input 0 ≤ V <sub>IN</sub> ≤ V <sub>IN</sub> +0.5V, all other input pins not under test=0 Volt)	I <sub>I(L)</sub>	-5	5	μA
	Output Leakage Current (Data out is disabled, 0V ≤ V <sub>OUT</sub> ≤ V <sub>CC</sub> )	I <sub>O(L)</sub>	-5	5	μA
	Output High Voltage Level(I <sub>OH</sub> =-5mA)	V <sub>OH</sub>	2.4	-	V
	Output Low Voltage Level(I <sub>OL</sub> =4.2mA)	V <sub>OL</sub>	-	0.4	V

## DC AND OPERATING CHARACTERISTICS (Continued)

Symbol	Power	Speed	Max		Units
			KM416V254D	KM416C254D	
I <sub>CC1</sub>	Don't care	-5	-	110	mA
		-6	90	90	mA
		-7	80	80	mA
I <sub>CC2</sub>	Don't care	Don't care	1	2	mA
I <sub>CC3</sub>	Don't care	-5	-	110	mA
		-6	90	90	mA
		-7	80	80	mA
I <sub>CC4</sub>	Don't care	-5	-	70	mA
		-6	60	60	mA
		-7	55	55	mA
I <sub>CC5</sub>	Normal L	Don't care	0.5	1	mA
			100	150	uA
I <sub>CC6</sub>	Don't care	-5	-	110	mA
		-6	90	90	mA
		-7	80	80	mA
I <sub>CC7</sub>	L	Don't care	200	300	uA
I <sub>CCS</sub>	L	Don't care	100	200	uA

I<sub>CC1</sub>\* : Operating Current ( $\overline{RAS}$  and  $\overline{UCAS}$ ,  $\overline{LCAS}$ , Address cycling @t<sub>RC</sub>=min.)

I<sub>CC2</sub> : Standby Current ( $\overline{RAS}=\overline{UCAS}=\overline{LCAS}=\overline{W}=V_{IH}$ )

I<sub>CC3</sub>\* :  $\overline{RAS}$ -only Refresh Current ( $\overline{UCAS}=\overline{LCAS}=V_{IH}$ ,  $\overline{RAS}$ , Address cycling @t<sub>RC</sub>=min.)

I<sub>CC4</sub>\* : Fast Page Mode Current ( $\overline{RAS}=V_{IL}$ ,  $\overline{UCAS}$  or  $\overline{LCAS}$ , Address cycling @t<sub>PC</sub>=min.)

I<sub>CC5</sub> : Standby Current ( $\overline{RAS}=\overline{UCAS}=\overline{LCAS}=\overline{W}=V_{CC}-0.2V$ )

I<sub>CC6</sub>\* :  $\overline{CAS}$ -Before- $\overline{RAS}$  Refresh Current ( $\overline{RAS}$  and  $\overline{UCAS}$  or  $\overline{LCAS}$  cycling @t<sub>RC</sub>=min.)

I<sub>CC7</sub> : Battery back-up current, Average power supply current, Battery back-up mode

Input high voltage(V<sub>IH</sub>)=V<sub>CC</sub>-0.2V, Input low voltage(V<sub>IL</sub>)=0.2V,  $\overline{UCAS}$ ,  $\overline{LCAS}$ =0.2V,

Din=Don't care, t<sub>RC</sub>=125us, t<sub>TRAS</sub>=t<sub>TRASmin</sub>~300ns

I<sub>CCS</sub> : Self Refresh Current

$\overline{RAS}=\overline{UCAS}=\overline{LCAS}=V_{IL}$ ,  $\overline{W}=\overline{OE}=A_0 \sim A_8=V_{CC}-0.2V$  or 0.2V,

DQ0 ~ DQ15=V<sub>CC</sub>-0.2V, 0.2V or Open

**\*Note :** I<sub>CC1</sub>, I<sub>CC3</sub>, I<sub>CC4</sub> and I<sub>CC6</sub> are dependent on output loading and cycle rates. Specified values are obtained with the output open. I<sub>CC</sub> is specified as an average current. In I<sub>CC1</sub>, I<sub>CC3</sub>, I<sub>CC6</sub> and I<sub>CC7</sub>, address can be changed maximum once while  $\overline{RAS}=V_{IL}$ . In I<sub>CC4</sub>, address can be changed maximum once within one fast page mode cycle time, t<sub>PC</sub>.

## CAPACITANCE (TA=25jE, VCC=5V or 3.3V, f=1MHz)

Parameter	Symbol	Min	Max	Units
Input capacitance [A0 ~ A8]	CIN1	-	5	pF
Input capacitance [ $\overline{\text{RAS}}$ , $\overline{\text{UCAS}}$ , $\overline{\text{LCAS}}$ , $\overline{\text{W}}$ , $\overline{\text{OE}}$ ]	CIN2	-	7	pF
Output capacitance [DQ0 - DQ15]	CDQ	-	7	pF

## AC CHARACTERISTICS (0jEjATAj70jE, See note 1,2)

Test condition (5V device) : VCC=5.0Vj%10%, Vih/Vil=2.4/0.8V, Voh/Vol=2.4/0.4V

Test condition (3.3V device) : VCC=3.3Vj%0.3V, Vih/Vil=2.2/0.7V, Voh/Vol=2.0/0.8V

Parameter	Symbol	-5 *1		-6		-7		Units	Notes
		Min	Max	Min	Max	Min	Max		
Random read or write cycle time	tRC	90		110		130		ns	
Read-modify-write cycle time	tRWC	132		152		177		ns	
Access time from $\overline{\text{RAS}}$	tRAC		50		60		70	ns	3,4,10
Access time from $\overline{\text{CAS}}$	tCAC		15		15		20	ns	3,4,5
Access time from column address	tAA		25		30		35	ns	3,10
$\overline{\text{CAS}}$ to output in Low-Z	tCLZ	0		0		0		ns	3
Output buffer turn-off delay	tOFF	0	12	0	12	0	17	ns	6
Transition time (rise and fall)	tT	3	50	3	50	3	50	ns	2
$\overline{\text{RAS}}$ precharge time	tRP	30		40		50		ns	
$\overline{\text{RAS}}$ pulse width	tRAS	50	10K	60	10K	70	10K	ns	
$\overline{\text{RAS}}$ hold time	tRSH	15		15		20		ns	
$\overline{\text{CAS}}$ hold time	tCSH	50		60		70		ns	
$\overline{\text{CAS}}$ pulse width	tCAS	15	10K	15	10K	20	10K	ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ delay time	tRCD	20	35	20	45	20	50	ns	4
$\overline{\text{RAS}}$ to column address delay time	tRAD	15	25	15	30	15	35	ns	10
$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ precharge time	tCRP	5		5		5		ns	
Row address set-up time	tASR	0		0		0		ns	
Row address hold time	tRAH	10		10		10		ns	
Column address set-up time	tASC	0		0		0		ns	12
Column address hold time	tCAH	10		10		15		ns	12
Column address to $\overline{\text{RAS}}$ lead time	tRAL	25		30		35		ns	
Read command set-up time	tRCS	0		0		0		ns	
Read command hold time referenced to $\overline{\text{CAS}}$	tRCH	0		0		0		ns	8
Read command hold time referenced to $\overline{\text{RAS}}$	tRRH	0		0		0		ns	8
Write command set-up time	tWCS	0		0		0		ns	7
Write command hold time	tWCH	10		10		15		ns	
Write command pulse width	tWP	10		10		15		ns	
Write command to $\overline{\text{RAS}}$ lead time	tRWL	15		15		15		ns	
Write command to $\overline{\text{CAS}}$ lead time	tCWL	13		15		15		ns	15

Note) \*1 : 5V only



**AC CHARACTERISTICS** (Continued)

Parameter	Symbol	<sup>*15</sup>		-6		-7		Units	Notes
		Min	Max	Min	Max	Min	Max		
Data set-up time	tDS	0		0		0		ns	9,19
Data hold time	tDH	10		10		15		ns	9,19
Refresh period (Normal)	tREF		8		8		8	ms	
Refresh period (L-ver)	tREF		128		128		128	ms	
$\overline{\text{CAS}}$ to $\overline{\text{W}}$ delay time	tCWD	37		37		47		ns	7,14
$\overline{\text{RAS}}$ to $\overline{\text{W}}$ delay time	trWD	72		82		97		ns	7
Column address to $\overline{\text{W}}$ delay time	tAWD	47		52		62		ns	7
$\overline{\text{CAS}}$ precharge to $\overline{\text{W}}$ delay time	tCPWD	52		57		67		ns	7
$\overline{\text{CAS}}$ set-up time ( $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh)	tCSR	10		10		10		ns	17
$\overline{\text{CAS}}$ hold time ( $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh)	tCHR	10		10		10		ns	18
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ precharge time	trPC	5		5		5		ns	
$\overline{\text{CAS}}$ precharge time (CBR counter test cycle)	tCPT	20		20		25		ns	
Access time from $\overline{\text{CAS}}$ precharge	tCPA		30		35		40	ns	3
Fast Page mode cycle time	tPC	35		40		45		ns	
Fast Page read-modify-write cycle time	tPRWC	77		82		97		ns	
$\overline{\text{CAS}}$ precharge time (Fast Page cycle)	tCP	10		10		10		ns	13
$\overline{\text{RAS}}$ pulse width (Fast Page cycle)	trASP	50	100K	60	100K	70	100K	ns	
$\overline{\text{RAS}}$ hold time from $\overline{\text{CAS}}$ precharge	trHCP	30		35		40		ns	
$\overline{\text{OE}}$ access time	toEA		15		15		20	ns	
$\overline{\text{OE}}$ to data delay	toED	12		12		17		ns	
Output buffer turn off delay time from $\overline{\text{OE}}$	toEZ	0	12	0	12	0	17	ns	6
$\overline{\text{OE}}$ command hold time	toEH	15		15		20		ns	
$\overline{\text{RAS}}$ pulse width (C-B-R self refresh)	trASS	100		100		100		us	11
$\overline{\text{RAS}}$ precharge time (C-B-R self refresh)	trPS	90		110		130		ns	11
$\overline{\text{CAS}}$ hold time (C-B-R self refresh)	tCHS	-50		-50		-50		ns	11

Note) \*1 : 5V only

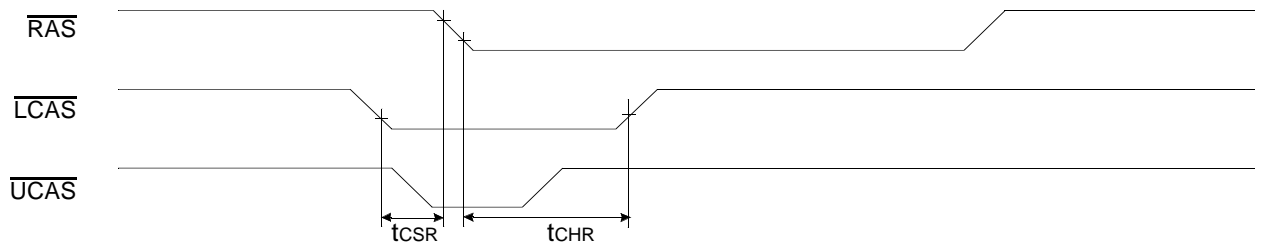
## NOTES

1. An initial pause of 200us is required after power-up followed by any 8 ROR or  $\overline{\text{C}}\overline{\text{B}}\overline{\text{R}}$  cycles before proper device operation is achieved.
2. Input voltage levels are  $V_{ih}/V_{il}$ .  $V_{IH}(\text{min})$  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)/1TTL(3.3V) loads and 50pF.
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  $t_{\text{RCD}}$  is greater than the specified  $t_{\text{RCD}}(\text{max})$  limit, then access time is controlled exclusively by  $t_{\text{CAC}}$ .
5. Assumes that  $t_{\text{RCD}} \leq t_{\text{RCD}}(\text{max})$ .
6. This parameter defines the time at which the output achieves the open circuit condition and is not referenced to  $V_{oh}$  or  $V_{ol}$ .
7.  $t_{\text{WCS}}$ ,  $t_{\text{RWD}}$ ,  $t_{\text{CWD}}$ ,  $t_{\text{AWD}}$  and  $t_{\text{CPWD}}$  are non restrictive operating parameters. They are included in the data sheet as electrical characteristics only. If  $t_{\text{WCS}} \leq t_{\text{WCS}}(\text{min})$ , the cycles is an early write cycle and the data output will remain high impedance for the duration of the cycle. If  $t_{\text{CWD}} \leq t_{\text{CWD}}(\text{min})$ ,  $t_{\text{RWD}} \leq t_{\text{RWD}}(\text{min})$ ,  $t_{\text{AWD}} \leq t_{\text{AWD}}(\text{min})$  and  $t_{\text{CPWD}} \leq t_{\text{CPWD}}(\text{min})$  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  $t_{\text{RCH}}$  or  $t_{\text{RRH}}$  must be satisfied for a read cycle.
9. These parameters are referenced to the  $\overline{\text{C}}\overline{\text{A}}\overline{\text{S}}$  leading edge in early write cycles and to the  $\overline{\text{W}}$  FALLing edge in  $\overline{\text{O}}\overline{\text{E}}$  controlled write cycle and 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  $t_{\text{RAD}}$  is greater than the specified  $t_{\text{RAD}}(\text{max})$  limit, then access time is controlled by  $t_{\text{AA}}$ .

## KM416C/V256D/DL Truth Table

$\overline{\text{R}}\overline{\text{A}}\overline{\text{S}}$	$\overline{\text{L}}\overline{\text{C}}\overline{\text{A}}\overline{\text{S}}$	$\overline{\text{U}}\overline{\text{C}}\overline{\text{A}}\overline{\text{S}}$	$\overline{\text{W}}$	$\overline{\text{O}}\overline{\text{E}}$	DQ0 - DQ7	DQ8-DQ15	STATE
H	H	H	H	H	Hi-Z	Hi-Z	Standby
L	H	H	H	H	Hi-Z	Hi-Z	Refresh
L	L	H	H	L	DQ-OUT	Hi-Z	Byte Read
L	H	L	H	L	Hi-Z	DQ-OUT	Byte Read
L	L	L	H	L	DQ-OUT	DQ-OUT	Word Read
L	L	H	L	H	DQ-IN	-	Byte Write
L	H	L	L	H	-	DQ-IN	Byte Write
L	L	L	L	H	DQ-IN	DQ-IN	Word Write
L	L	L	H	H	Hi-Z	Hi-Z	-

11. 512cycle of burst refresh must be executed within 8ms before and after self refresh in order to meet refresh specification (L-version).
12. tASC, tCAH are referenced to the earlier  $\overline{\text{CAS}}$  rising edge.
13. tCP is specified from the last  $\overline{\text{CAS}}$  rising edge in the previous cycle to the first  $\overline{\text{CAS}}$  falling edge in the next cycle.
14. tCWD is referenced to the later  $\overline{\text{CAS}}$  falling edge at word red-modify-write cycle.
15. tcWL is specified from  $\overline{\text{W}}$  falling edge to the earlier  $\overline{\text{CAS}}$  rising edge.
16. tCSR is referenced to earlier  $\overline{\text{CAS}}$  falling low before  $\overline{\text{RAS}}$  transition low.
17. tCHR is referenced to the later  $\overline{\text{CAS}}$  rising high after  $\overline{\text{RAS}}$  transition low.



20. tDS, tDH are specified for earlier  $\overline{\text{CAS}}$  falling low.

