

## Description

The GM71V(S)16160C/CL is the new generation dynamic RAM organized 1,048,576 x 16 bit. GM71V(S)16160C/CL has realized higher density, higher performance and various functions by utilizing advanced CMOS process technology. The GM71V(S)16160C/CL offers Fast Page Mode as a high speed access mode. Multiplexed address inputs permit the GM71V(S)16160C/CL to be packaged in standard 400 mil 42pin plastic SOJ, and standard 400mil 44(50)pin plastic TSOP II. The package size provides high system bit densities and is compatible with widely available automated testing and insertion equipment.

## Features

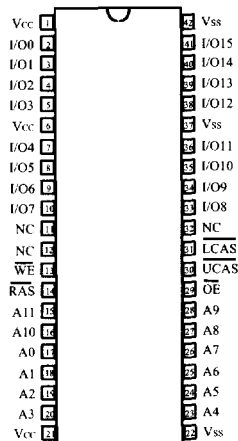
- \* 1,048,576 Words x 16 Bit Organization
- \* Fast Page Mode Capability
- \* Single Power Supply (3.3V $\pm$ -0.3V)
- \* Fast Access Time & Cycle Time (Unit: ns)

	t <sub>TRAC</sub>	t <sub>CAC</sub>	t <sub>RC</sub>	t <sub>PC</sub>
GM71V(S)16160C/CL-5	50	13	90	35
GM71V(S)16160C/CL-6	60	15	110	40
GM71V(S)16160C/CL-7	70	18	130	45

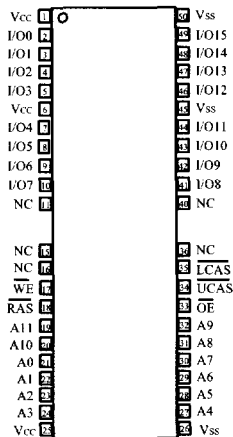
- \* Low Power  
Active : 396/360/324mW (MAX)  
Standby : 7.2mW (CMOS level : MAX)  
0.54mW (L-version : MAX)
- \* RAS Only Refresh, CAS before RAS Refresh, Hidden Refresh Capability
- \* All inputs and outputs TTL Compatible
- \* 4096 Refresh Cycles/64ms
- \* 4096 Refresh Cycles/128ms (L-version)
- \* Self Refresh Operation (L-version)
- \* Battery Back Up Operation (L-version)
- \* 2 CAS byte Control

## Pin Configuration

42 SOJ



44(50)TSOP II



(Top View)

16M-bit  
DRAM

## Pin Description

Pin	Function	Pin	Function
A0-A11	Address Inputs	$\overline{\text{WE}}$	Read/Write Enable
A0-A11	Refresh Address Inputs	$\overline{\text{OE}}$	Output Enable
I/O0-I/O15	Data Input/ Data Output	V <sub>cc</sub>	Power (+3.3V)
$\overline{\text{RAS}}$	Row Address Strobe	V <sub>ss</sub>	Ground
$\overline{\text{UCAS, LCAS}}$	Column Address Strobe	NC	No Connection

## Ordering Information

Type No.	Access Time	Package
GM71V(S)16160CJ/CLJ -5 GM71V(S)16160CJ/CLJ -6 GM71V(S)16160CJ/CLJ -7	50ns 60ns 70ns	400 Mil 42 Pin Plastic SOJ
GM71V(S)16160CT/CLT -5 GM71V(S)16160CT/CLT -6 GM71V(S)16160CT/CLT -7	50ns 60ns 70ns	400 Mil 44(50) Pin Plastic TSOP II

## Absolute Maximum Ratings\*

Symbol	Parameter	Rating	Unit
T <sub>A</sub>	Ambient Temperature under Bias	0 ~ 70	C
T <sub>STG</sub>	Storage Temperature	-55 ~ 125	C
V <sub>IN/OUT</sub>	Voltage on any Pin Relative to V <sub>ss</sub>	-0.5 ~ V <sub>cc</sub> +0.5 (≤4.6V(MAX))	V
V <sub>CC</sub>	Supply Voltage Relative to V <sub>ss</sub>	-0.5 ~ 4.6	V
I <sub>OUT</sub>	Short Circuit Output Current	50	mA
P <sub>D</sub>	Power Dissipation	1.0	W

Note: Operation at or above Absolute Maximum Ratings can adversely affect device reliability.

Recommended DC Operating Conditions ( $T_A = 0 \sim +70^\circ\text{C}$ )

Symbol	Parameter	Min	Typ	Max	Unit
$V_{CC}$	Supply Voltage	3.0	3.3	3.6	V
$V_{IH}$	Input High Voltage	2.0	-	$V_{CC} + 0.3$	V
$V_{IL}$	Input Low Voltage	-0.3	-	0.8	V

Note: All voltage referred to  $V_{SS}$ .

The supply voltage with all VCC pins must be on the same level. The supply voltage with all VSS pins must be on the same level.

## Truth Table

$\overline{\text{RAS}}$	$\overline{\text{LCAS}}$	$\overline{\text{UCAS}}$	$\overline{\text{WE}}$	$\overline{\text{OE}}$	Output	Operation	Notes
H	D	D	D	D	Open	Standby	1,3
L	L	H	H	L	Valid	Lower byte	Read cycle 1,3
L	H	L	H	L	Valid	Upper byte	
L	L	L	H	L	Valid	Word	
L	L	H	L	D	Open	Lower byte	Early write cycle 1,2,3
L	H	L	L	D	Open	Upper byte	
L	L	L	L	D	Open	Word	
L	L	H	L	H	Undefined	Lower byte	Delayed Write cycle 1,2,3
L	H	L	L	H	Undefined	Upper byte	
L	L	L	L	H	Undefined	Word	
L	L	H	H to L	L to H	Valid	Lower byte	Read-modify -write cycle 1,3
L	H	L	H to L	L to H	Valid	Upper byte	
L	L	L	H to L	L to H	Valid	Word	
H to L	H	L	D	D	Open	Word	CBR Refresh or Self Refresh (L-series) 1,3
H to L	L	H	D	D	Open	Word	
H to L	L	L	D	D	Open	Word	
L	H	H	D	D	Open	Word	RAS-only Refresh cycle 1,3
L	L	L	H	H	Open	Read cycle (Output disabled)	1,3

Notes: 1. H: High (inactive) L: Low(active) D: H or L

2.  $t_{wCS} \geq 0\text{ns}$  Early write cycle

$t_{wCS} \leq 0\text{ns}$  Delayed write cycle

3. Mode is determined by the OR function of the  $\overline{\text{UCAS}}$  and  $\overline{\text{LCAS}}$ . (Mode is set by earliest of  $\overline{\text{UCAS}}$  and  $\overline{\text{LCAS}}$  active edge and reset by the latest of  $\overline{\text{UCAS}}$  and  $\overline{\text{LCAS}}$  inactive edge.) However write OPERATION and output High-Z control are done independently by each  $\overline{\text{UCAS}}$ ,  $\overline{\text{LCAS}}$ .  
ex) if RAS = H to L, UCAS = H, LCAS = L, then CAS-before-RAS refresh cycle is selected.

## DC Electrical Characteristics ( $V_{CC} = 3.3V \pm 0.3V$ , $V_{SS} = 0V$ , $T_A = 0 \sim 70C$ )

Symbol	Parameter	Min	Max	Unit	Note	
$V_{OH}$	Output Level Output "H" Level Voltage ( $I_{OUT} = -2mA$ )	2.4	$V_{CC}$	V		
$V_{OL}$	Output Level Output "L" Level Voltage ( $I_{OUT} = 2mA$ )	0	0.4	V		
$I_{CC1}$	Operating Current Average Power Supply Operating Current (RAS, UCAS or LCAS Cycling: $t_{RC} = t_{RC\ min}$ )	50ns	-	110	mA	1, 2
		60ns	-	100		
		70ns	-	90		
$I_{CC2}$	Standby Current (TTL) Power Supply Standby Current (RAS, UCAS, LCAS = $V_{IH}$ , $D_{OUT} = High-Z$ )	-	2	mA		
$I_{CC3}$	RAS Only Refresh Current Average Power Supply Current RAS Only Refresh Mode ( $t_{RC} = t_{RC\ min}$ )	50ns	-	110	mA	2
		60ns	-	100		
		70ns	-	90		
$I_{CC4}$	Fast Page Mode Current Average Power Supply Current Fast Page Mode ( $t_{RC} = t_{RC\ min}$ )	50ns	-	115	mA	1, 3
		60ns	-	105		
		70ns	-	95		
$I_{CC5}$	Standby Current (CMOS) Power Supply Standby Current (RAS, UCAS or LCAS $\geq V_{CC} - 0.2V$ , $D_{OUT} = High-Z$ )	-	1	mA		
		-	150	$\mu A$	5	
$I_{CC6}$	CAS-before-RAS Refresh Current ( $t_{RC} = t_{RC\ min}$ )	50ns	-	110	mA	
		60ns	-	100		
		70ns	-	90		
$I_{CC7}$	Battery Back Up Operating Current (Standby with CBR Refresh) ( $t_{RC}=31.3\mu s$ , $t_{RAS}\leq 0.3\mu s$ , $D_{OUT}=High-Z$ )	-	400	$\mu A$	4,5	
$I_{CC8}$	Standby Current $\overline{RAS} = V_{IH}$ UCAS, LCAS = $V_{IL}$ $D_{OUT} = Enable$	-	5	mA	1	
$I_{CC9}$	Self-Refresh Mode Current (RAS, UCAS or LCAS $\leq 0.2V$ , $D_{OUT}=High-Z$ )	-	250	$\mu A$	5	
$I_{L(i)}$	Input Leakage Current Any Input ( $0V \leq V_{IN} \leq 4.6V$ )	-10	10	$\mu A$		
$I_{L(O)}$	Output Leakage Current ( $D_{OUT}$ is Disabled, $0V \leq V_{OUT} \leq 4.6V$ )	-10	10	$\mu A$		

Note: 1.  $I_{CC}$  depends on output load condition when the device is selected.

$I_{CC(max)}$  is specified at the output open condition.

- Address can be changed once or less while  $\overline{RAS} = V_{IL}$ .
- Address can be changed once or less while  $\overline{UCAS}$  and  $\overline{LCAS} = V_{IH}$ .
- $\overline{UCAS} = L$  ( $\leq 0.2$ ) and  $\overline{LCAS} = L$  ( $\leq 0.2$ ) while  $\overline{RAS} = L$  ( $\leq 0.2$ ).
- L-version.

Capacitance ( $V_{CC} = 3.3V \pm 0.3V$ ,  $T_A = 25C$ )

Symbol	Parameter	Min	Max	Unit	Note
$C_{I1}$	Input Capacitance (Address)	-	5	pF	1
$C_{I2}$	Input Capacitance (Clocks)	-	7	pF	1
$C_{I/O}$	Output Capacitance (Data-In/Out)	-	7	pF	1, 2

Note: 1. Capacitance measured with Boonton Meter or effective capacitance measuring method.  
2. UCAS and LCAS =  $V_{IH}$  to disable  $D_{OUT}$ .

AC Characteristics ( $V_{CC} = 3.3V \pm 0.3V$ ,  $T_A = 0 \sim +70C$ , Note 1, 2, 18, 19, 20)

## Test Conditions

Input rise and fall times : 5 ns

Output timing reference levels : 0.8V, 2.0V

Input timing reference levels : 0.8V, 2.0V

Output load : 1TTL gate +  $C_L$  (100 pF)

(Including scope and jig)

## Read, Write, Read-Modify-Write and Refresh Cycles (Common Parameters)

Symbol	Parameter	GM71V(S)16160 C/CL-5		GM71V(S)16160 C/CL-6		GM71V(S)16160 C/CL-7		Unit	Note
		Min	Max	Min	Max	Min	Max		
		$t_{RC}$	Random Read or Write Cycle Time	90	-	110	-		
$t_{RP}$	$\overline{RAS}$ Precharge Time	30	-	40	-	50	-	ns	
$t_{CP}$	$\overline{CAS}$ Precharge Time	8	-	10	-	10	-	ns	24
$t_{RAS}$	$\overline{RAS}$ Pulse Width	50	10,000	60	10,000	70	10,000	ns	
$t_{CAS}$	$\overline{CAS}$ Pulse Width	13	10,000	15	10,000	18	10,000	ns	
$t_{ASR}$	Row Address Set up Time	0	-	0	-	0	-	ns	
$t_{RAH}$	Row Address Hold Time	8	-	10	-	10	-	ns	
$t_{ASC}$	Column Address Set-up Time	0	-	0	-	0	-	ns	21
$t_{CAH}$	Column Address Hold Time	8	-	10	-	15	-	ns	21
$t_{RCD}$	$\overline{RAS}$ to $\overline{CAS}$ Delay Time	18	45	20	45	20	52	ns	3
$t_{RAD}$	$\overline{RAS}$ to Column Address Delay Time	13	30	15	30	15	35	ns	4
$t_{RSH}$	$\overline{RAS}$ Hold Time	13	-	15	-	18	-	ns	
$t_{CSH}$	$\overline{CAS}$ Hold Time	50	-	60	-	70	-	ns	23
$t_{CRP}$	$\overline{CAS}$ to $\overline{RAS}$ Precharge Time	5	-	5	-	5	-	ns	22
$t_{ODD}$	$\overline{OE}$ to $D_{IN}$ Delay Time	13	-	15	-	18	-	ns	5
$t_{DZO}$	$\overline{OE}$ Delay Time from $D_{IN}$	0	-	0	-	0	-	ns	6
$t_{DZC}$	$\overline{CAS}$ Delay Time from $D_{IN}$	0	-	0	-	0	-	ns	6
$t_r$	Transition Time (Rise and Fall)	3	50	3	50	3	50	ns	7

## Read Cycle

Symbol	Parameter	GM71V(S)16160 C/CL-5		GM71V(S)16160 C/CL-6		GM71V(S)16160 C/CL-7		Unit	Note
		Min	Max	Min	Max	Min	Max		
t <sub>RAC</sub>	Access Time from $\overline{\text{RAS}}$	-	50	-	60	-	70	ns	8,9
t <sub>CAC</sub>	Access Time from $\overline{\text{CAS}}$	-	13	-	15	-	18	ns	9,10,17
t <sub>AA</sub>	Access Time from Address	-	25	-	30	-	35	ns	9,11,17
t <sub>OAC</sub>	Access Time from $\overline{\text{OE}}$	-	13	-	15	-	18	ns	9,25
t <sub>RCS</sub>	Read Command Setup Time	0	-	0	-	0	-	ns	
t <sub>RCH</sub>	Read Command Hold Time to $\overline{\text{CAS}}$	0	-	0	-	0	-	ns	12,22
t <sub>RRH</sub>	Read Command Hold Time to $\overline{\text{RAS}}$	5	-	5	-	5	-	ns	12
t <sub>RAL</sub>	Column Address to $\overline{\text{RAS}}$ Lead Time	25	-	30	-	35	-	ns	
t <sub>CAL</sub>	Column Address to $\overline{\text{CAS}}$ Lead Time	25	-	30	-	35	-	ns	
t <sub>CLZ</sub>	$\overline{\text{CAS}}$ to Output in Low-Z	0	-	0	-	0	-	ns	
t <sub>OH</sub>	Output Data Hold Time	3	-	3	-	3	-	ns	
t <sub>OHO</sub>	Output Data Hold Time from $\overline{\text{OE}}$	3	-	3	-	3	-	ns	
t <sub>OFF</sub>	Output Buffer Turn-off Time	-	13	-	15	-	15	ns	13
t <sub>OEZ</sub>	Output Buffer Turn-off Time to $\overline{\text{OE}}$	-	13	-	15	-	15	ns	13
t <sub>CDD</sub>	$\overline{\text{CAS}}$ to $\overline{\text{DIN}}$ Delay Time	13	-	15	-	18	-	ns	5

## Write Cycle

Symbol	Parameter	GM71V(S)16160 C/CL-5		GM71V(S)16160 C/CL-6		GM71V(S)16160 C/CL-7		Unit	Note
		Min	Max	Min	Max	Min	Max		
t <sub>WCS</sub>	Write Command Setup Time	0	-	0	-	0	-	ns	14,21
t <sub>WCH</sub>	Write Command Hold Time	8	-	10	-	15	-	ns	21
t <sub>WP</sub>	Write Command Pulse Width	8	-	10	-	10	-	ns	
t <sub>RWL</sub>	Write Command to $\overline{\text{RAS}}$ Lead Time	13	-	15	-	18	-	ns	
t <sub>CWL</sub>	Write Command to $\overline{\text{CAS}}$ Lead Time	13	-	15	-	18	-	ns	23
t <sub>DS</sub>	Data-in Setup Time	0	-	0	-	0	-	ns	15,23
t <sub>DH</sub>	Data-in Hold Time	8	-	10	-	15	-	ns	15,23

## Read-Modify-Write Cycle

Symbol	Parameter	GM71V(S)16160 C/CL-5		GM71V(S)16160 C/CL-6		GM71V(S)16160 C/CL-7		Unit	Note
		Min	Max	Min	Max	Min	Max		
t <sub>RWC</sub>	Read-Modify-Write Cycle Time	131	-	155	-	181	-	ns	
t <sub>RWD</sub>	$\overline{\text{RAS}}$ to $\overline{\text{WE}}$ Delay Time	73	-	85	-	98	-	ns	14
t <sub>CWD</sub>	$\overline{\text{CAS}}$ to $\overline{\text{WE}}$ Delay Time	36	-	40	-	46	-	ns	14
t <sub>AWD</sub>	Column Address to $\overline{\text{WE}}$ Delay Time	48	-	55	-	63	-	ns	14
t <sub>OEH</sub>	$\overline{\text{OE}}$ Hold Time from $\overline{\text{WE}}$	13	-	15	-	18	-	ns	

## Refresh Cycle

Symbol	Parameter	GM71V(S)16160 C/CL-5		GM71V(S)16160 C/CL-6		GM71V(S)16160 C/CL-7		Unit	Note
		Min	Max	Min	Max	Min	Max		
t <sub>CSR</sub>	$\overline{\text{CAS}}$ Setup Time ( $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ Refresh Cycle)	5	-	5	-	5	-	ns	21
t <sub>CHR</sub>	$\overline{\text{CAS}}$ Hold Time ( $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ Refresh Cycle)	8	-	10	-	10	-	ns	22
t <sub>RPC</sub>	$\overline{\text{RAS}}$ Precharge to $\overline{\text{CAS}}$ Hold Time	5	-	5	-	5	-	ns	21

## Fast Page Mode Cycle

Symbol	Parameter	GM71V(S)16160 C/CL-5		GM71V(S)16160 C/CL-6		GM71V(S)16160 C/CL-7		Unit	Note
		Min	Max	Min	Max	Min	Max		
t <sub>PC</sub>	Fast Page Mode Cycle Time	35	-	40	-	45	-	ns	
t <sub>RASP</sub>	Fast Page Mode $\overline{\text{RAS}}$ Pulse Width	-	100,000	-	100,000	-	100,000	ns	16
t <sub>ACP</sub>	Access Time from $\overline{\text{CAS}}$ Precharge	-	30	-	35	-	40	ns	9,17,22
t <sub>RHCP</sub>	$\overline{\text{RAS}}$ Hold Time from $\overline{\text{CAS}}$ Precharge	30	-	35	-	40	-	ns	

## Fast Page Mode Read-Modify-Write Cycle

Symbol	Parameter	GM71V(S)16160 C/CL-5		GM71V(S)16160 C/CL-6		GM71V(S)16160 C/CL-7		Unit	Note
		Min	Max	Min	Max	Min	Max		
t <sub>PRWC</sub>	Fast Page Mode Read-Modify-Write Cycle Time	76	-	85	-	96	-	ns	
t <sub>CPW</sub>	$\overline{\text{WE}}$ Delay Time from $\overline{\text{CAS}}$ Precharge	53	-	60	-	68	-	ns	14,22

## Self Refresh Mode

Symbol	Parameter	GM71VS16160 CL-5		GM71VS16160 CL-6		GM71VS16160 CL-7		Unit	Note
		Min	Max	Min	Max	Min	Max		
t <sub>RASS</sub>	$\overline{\text{RAS}}$ Pulse Width(Self-Refresh)	100	-	100	-	100	-	us	26
t <sub>RPS</sub>	$\overline{\text{RAS}}$ Precharge Time(Self-Refresh)	90	-	110	-	130	-	ns	
t <sub>CHS</sub>	$\overline{\text{CAS}}$ Hold Time(Self-Refresh)	-50	-	-50	-	-50	-	ns	

### Notes:

- AC measurements assume  $t_T = 5\text{ns}$ .
- An initial pause of 200us is required after power up followed by a minimum of eight initialization cycles(any combination of cycles containing  $\overline{\text{RAS}}$ -only refresh or  $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  refresh). If the internal refresh counter is used, a minimum of eight  $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  refresh cycles are required.
- Operation with the t<sub>RC</sub>(max) limit insures that t<sub>RAC</sub>(max) can be met, t<sub>RC</sub>(max) is specified as a reference point only; if  $t_{RC} \geq t_{RAD}(\text{max}) + t_{AA}(\text{max}) - t_{CAC}(\text{max})$ , then access time is controlled exclusively by t<sub>CAC</sub>.
- Operation with the t<sub>RD</sub>(max) limit insures that t<sub>RAC</sub>(max) can be met, t<sub>RD</sub>(max) is specified as a reference point only; if t<sub>RD</sub> is greater than the specified t<sub>RD</sub>(max) limit, then access time is controlled exclusively by t<sub>AA</sub>.
- Either t<sub>ODD</sub> or t<sub>CDD</sub> must be satisfied.
- Either t<sub>DZO</sub> or t<sub>DZC</sub> must be satisfied.
- V<sub>IH</sub>(min) and V<sub>IL</sub>(max) are reference levels for measuring timing of input signals. Also, transition times are measured between V<sub>IH</sub>(min) and V<sub>IL</sub>(max).
- Assumes that  $t_{RC} \leq t_{RC}(\text{max})$  and  $t_{RD} \leq t_{RD}(\text{max})$ . If t<sub>RC</sub> or t<sub>RD</sub> is greater than the maximum recommended value shown in this table, t<sub>RAC</sub> exceeds the value shown.
- Measured with a load circuit equivalent to 2 TTL load and 100pF.
- Assumes that  $t_{RC} \geq t_{RC}(\text{max})$  and  $t_{RC} + t_{CAC}(\text{max}) \geq t_{RD} + t_{AA}(\text{max})$ .
- Assumes that  $t_{RD} \geq t_{RD}(\text{max})$  and  $t_{RC} + t_{CAC}(\text{max}) \leq t_{RD} + t_{AA}(\text{max})$ .
- Either t<sub>TRC</sub> or t<sub>TRH</sub> must be satisfied for a read cycles.
- t<sub>OFF</sub>(max) and t<sub>OEZ</sub>(max) define the time at which the outputs achieve the open circuit condition and are not referred to output voltage levels.
- t<sub>WCS</sub>, t<sub>TRWD</sub>, t<sub>TCWD</sub>, t<sub>AWD</sub> and t<sub>CPW</sub> are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only; if  $t_{WCS} \geq t_{WCS}(\text{min})$ , the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if  $t_{TRWD} \geq t_{TRWD}(\text{min})$ ,  $t_{TCWD} \geq t_{TCWD}(\text{min})$ , and  $t_{AWD} \geq t_{AWD}(\text{min})$ , or  $t_{CPW} \geq t_{CPW}(\text{min})$ , the cycle is a read-modify-write and the data output will contain data read from the selected cell; if neither of the above sets of conditions is satisfied, the condition of data out (at access time) is indeterminate.



15. These parameters are referred to  $\overline{UCAS}$  and  $\overline{LCAS}$  leading edge in early write cycles and to WE leading edge in delayed write or read-modify-write cycles.
16.  $t_{RASP}$  defines RAS pulse width in fast page mode cycles.
17. Access time is determined by the longest among  $t_{AA}$ ,  $t_{CAC}$ , and  $t_{ACP}$ .
18. In delayed write or read-modify-write cycles,  $\overline{OE}$  must disable output buffer prior to applying data to the device. After RAS is reset, if  $t_{OEH} \geq t_{CWL}$ , the I/O pin will remain open circuit (high impedance); if  $t_{OEH} < t_{CWL}$ , invalid data will be out at each I/O.
19. When both  $\overline{UCAS}$  and  $\overline{LCAS}$  go low at the same time, all 16-bit data are written into the device.  $\overline{UCAS}$  and  $\overline{LCAS}$  cannot be staggered within the same write/read cycles.
20. All the  $V_{CC}$  and  $V_{SS}$  pins shall be supplied with the same voltages.
21.  $t_{ASC}$ ,  $t_{CAH}$ ,  $t_{RCS}$ ,  $t_{WCS}$ ,  $t_{WCH}$ ,  $t_{CSR}$  and  $t_{RPC}$  are determined by the earlier falling edge of  $\overline{UCAS}$  or  $\overline{LCAS}$ .
22.  $t_{CRP}$ ,  $t_{CHR}$ ,  $t_{RCH}$ ,  $t_{ACP}$  and  $t_{CPW}$  are determined by the later rising edge of  $\overline{UCAS}$  or  $\overline{LCAS}$ .
23.  $t_{CWL}$ ,  $t_{DH}$ ,  $t_{DS}$  and  $t_{CSH}$  should be satisfied by both  $\overline{UCAS}$  and  $\overline{LCAS}$ .
24.  $t_{CP}$  is determined by that time the both  $\overline{UCAS}$  and  $\overline{LCAS}$  are high.
25. When output buffers are enabled once, sustain the low impedance state until valid data is obtained.  
When output buffer is turned on and off within a very short time, generally it causes large  $V_{CC}/V_{SS}$  line noise, which causes to degrade  $V_{IH\ min}/V_{IL\ max}$  level.
26. Please do not use  $t_{RASS}$  timing,  $10\mu s \leq t_{RASS} \leq 100\mu s$ . During this period, the device is in transition state from normal operation mode to self refresh mode. If  $t_{RASS} \geq 100\mu s$ , then RAS precharge time should use  $t_{RPS}$  instead of  $t_{RP}$ .
27. H or L (H:  $V_{IH\ (min)} \leq V_{IN} \leq V_{IH\ (max)}$ , L:  $V_{IL\ (min)} \leq V_{IN} \leq V_{IL\ (max)}$ )

## Package Dimension

42pin SOJ

Unit: Inches (mm)

