

**MSM511664C/CL****65,536-Word × 16-Bit DYNAMIC RAM : FAST PAGE MODE TYPE (BYTE WRITE)****DESCRIPTION**

The MSM511664C/CL is a 65,536-word × 16-bit dynamic RAM fabricated in Oki's silicon-gate CMOS technology. The MSM511664C/CL achieves high integration, high-speed operation, and low-power consumption because Oki manufactures the device in a quadruple-layer polysilicon/single-layer metal CMOS process. The MSM511664C/CL is available in a 40-pin plastic SOJ or 44/40-pin plastic TSOP. The MSM511664CL (the low-power version) is specially designed for lower-power applications.

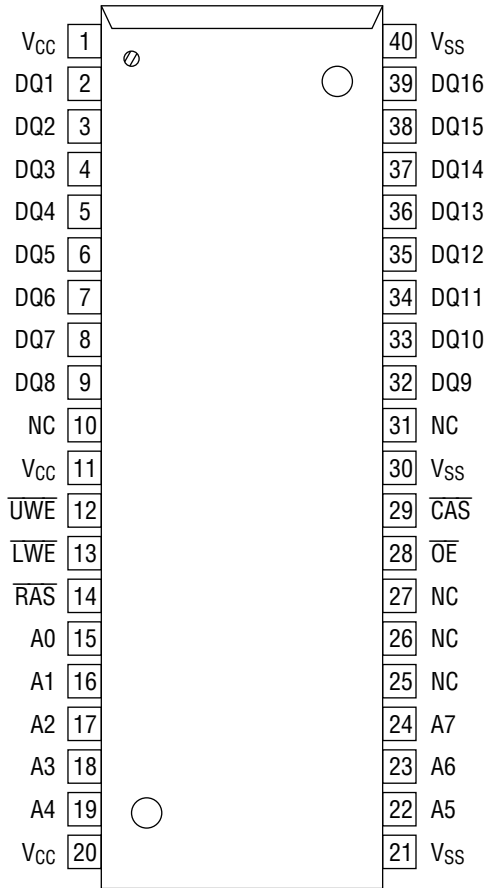
**FEATURES**

- 65,536-word × 16-bit configuration
  - Single 5 V power supply, ±10% tolerance
  - Input : TTL compatible, low input capacitance
  - Output : TTL compatible, 3-state
  - Refresh : 256 cycles/4 ms, 256 cycles/32 ms (L-version)
  - Byte write and fast page mode, read modify write capability
  - $\overline{\text{CAS}}$  before  $\overline{\text{RAS}}$  refresh, hidden refresh,  $\overline{\text{RAS}}$ -only refresh capability
  - Package options:
    - 40-pin 400 mil plastic SOJ (SOJ40-P-400-1.27) (Product : MSM511664C/CL-xxJS)
    - 44/40-pin 400 mil plastic TSOP (TSOPII44/40-P-400-0.80-K) (Product : MSM511664C/CL-xxTS-K)
- xx indicates speed rank.

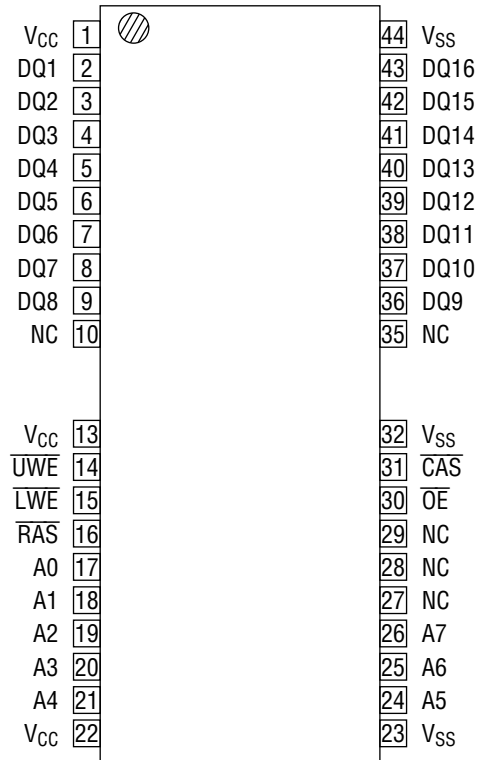
**PRODUCT FAMILY**

Family	Access Time (Max.)				Cycle Time (Min.)	Power Dissipation	
	t <sub>RAC</sub>	t <sub>AA</sub>	t <sub>CAC</sub>	t <sub>OEA</sub>		Operating (Max.)	Standby (Max.)
MSM511664C/CL-60	60 ns	30 ns	20 ns	20 ns	110 ns	550 mW	5.5 mW/ 1.1 mW (L-version)
MSM511664C/CL-70	70 ns	40 ns	25 ns	25 ns	120 ns	495 mW	
MSM511664C/CL-80	80 ns	45 ns	30 ns	30 ns	135 ns	440 mW	

**PIN CONFIGURATION (TOP VIEW)**



40-Pin Plastic SOJ

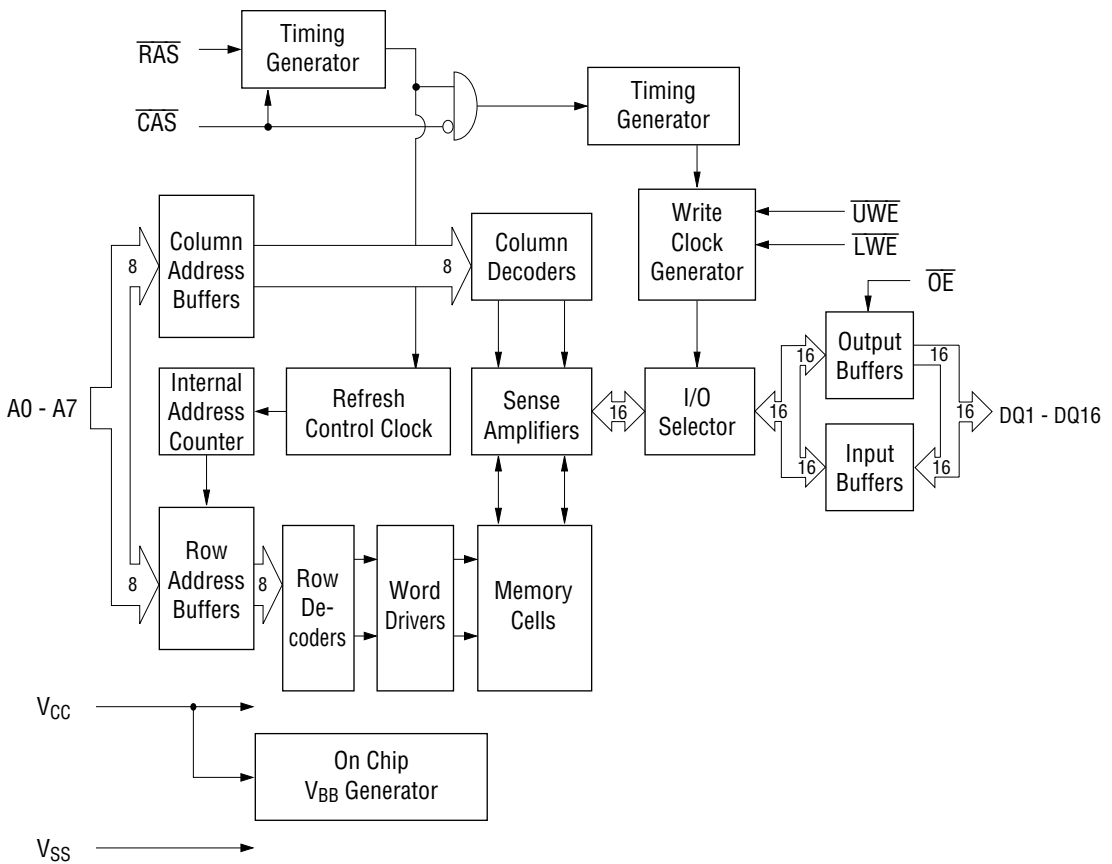


44/40-Pin Plastic TSOP  
(K Type)

Pin Name	Function
A0 - A7	Address Input
$\overline{\text{RAS}}$	Row Address Strobe
$\overline{\text{CAS}}$	Column Address Strobe
DQ1 - DQ16	Data Input/Data Output
$\overline{\text{OE}}$	Output Enable
$\overline{\text{LWE}}$	Lower Byte Write Enable
$\overline{\text{UWE}}$	Upper Byte Write Enable
V <sub>CC</sub>	Power Supply (5 V)
V <sub>SS</sub>	Ground (0 V)
NC	No Connection

Note : The same power supply voltage must be provided to every V<sub>CC</sub> pin, and the same GND voltage level must be provided to every V<sub>SS</sub> pin.

**BLOCK DIAGRAM**



**FUNCTION TABLE**

Input Pin					DQ Pin		Function Mode
RAS	CAS	LWE	UWE	OE	DQ1 - DQ8	DQ9 - DQ16	
H	*	*	*	*	High-Z	High-Z	Standby
L	H	*	*	*	High-Z	High-Z	Refresh
L	L	H	H	L	D <sub>OUT</sub>	D <sub>OUT</sub>	Word Read
L	L	L	H	H	D <sub>IN</sub>	Don't Care	Lower Byte Write
L	L	H	L	H	Don't Care	D <sub>IN</sub>	Upper Byte Write
L	L	L	L	H	D <sub>IN</sub>	D <sub>IN</sub>	Word Write
L	L	H	H	H	High-Z	High-Z	—

\*: "H" or "L"

## ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Voltage on Any Pin Relative to $V_{SS}$	$V_T$	-1.0 to 7.0	V
Short Circuit Output Current	$I_{OS}$	50	mA
Power Dissipation	$P_D^*$	1	W
Operating Temperature	$T_{opr}$	0 to 70	°C
Storage Temperature	$T_{stg}$	-55 to 150	°C

\*:  $T_a = 25^\circ\text{C}$

### Recommended Operating Conditions

( $T_a = 0^\circ\text{C}$  to  $70^\circ\text{C}$ )

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power Supply Voltage	$V_{CC}$	4.5	5.0	5.5	V
	$V_{SS}$	0	0	0	V
Input High Voltage	$V_{IH}$	2.4	—	6.5	V
Input Low Voltage	$V_{IL}$	-1.0	—	0.8	V

### Capacitance

( $V_{CC} = 5\text{ V} \pm 10\%$ ,  $T_a = 25^\circ\text{C}$ ,  $f = 1\text{ MHz}$ )

Parameter	Symbol	Typ.	Max.	Unit
Input Capacitance (A0 - A7)	$C_{IN1}$	—	7	pF
Input Capacitance ( $\overline{\text{RAS}}$ , $\overline{\text{CAS}}$ , $\overline{\text{UWE}}$ , $\overline{\text{LWE}}$ , $\overline{\text{OE}}$ )	$C_{IN2}$	—	7	pF
Output Capacitance (DQ1 - DQ16)	$C_{I/O}$	—	7	pF

DC Characteristics

( $V_{CC} = 5\text{ V} \pm 10\%$ ,  $T_a = 0^\circ\text{C}$  to  $70^\circ\text{C}$ )

Parameter	Symbol	Condition	MSM511664 C/CL-60		MSM511664 C/CL-70		MSM511664 C/CL-80		Unit	Note
			Min.	Max.	Min.	Max.	Min.	Max.		
Output High Voltage	$V_{OH}$	$I_{OH} = -2.5\text{ mA}$	2.4	$V_{CC}$	2.4	$V_{CC}$	2.4	$V_{CC}$	V	
Output Low Voltage	$V_{OL}$	$I_{OL} = 2.1\text{ mA}$	0	0.4	0	0.4	0	0.4	V	
Input Leakage Current	$I_{LI}$	$0\text{ V} \leq V_I \leq 6.5\text{ V}$ ; All other pins not under test = 0 V	-10	10	-10	10	-10	10	$\mu\text{A}$	
Output Leakage Current	$I_{LO}$	DQ disable $0\text{ V} \leq V_O \leq 5.5\text{ V}$	-10	10	-10	10	-10	10	$\mu\text{A}$	
Average Power Supply Current (Operating)	$I_{CC1}$	$\overline{\text{RAS}}$ , $\overline{\text{CAS}}$ cycling, $t_{RC} = \text{Min.}$	—	100	—	90	—	80	mA	1, 2
Power Supply Current (Standby)	$I_{CC2}$	$\overline{\text{RAS}}$ , $\overline{\text{CAS}} = V_{IH}$	—	2	—	2	—	2	mA	1
		$\overline{\text{RAS}}$ , $\overline{\text{CAS}}$ $\geq V_{CC} - 0.2\text{ V}$	—	1	—	1	—	1		
			—	200	—	200	—	200	$\mu\text{A}$	1, 5
Average Power Supply Current ( $\overline{\text{RAS}}$ -only Refresh)	$I_{CC3}$	$\overline{\text{RAS}}$ cycling, $\overline{\text{CAS}} = V_{IH}$ , $t_{RC} = \text{Min.}$	—	100	—	90	—	80	mA	1, 2
Power Supply Current (Standby)	$I_{CC5}$	$\overline{\text{RAS}} = V_{IH}$ , $\overline{\text{CAS}} = V_{IL}$ , DQ = enable	—	5	—	5	—	5	mA	1
Average Power Supply Current ( $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ Refresh)	$I_{CC6}$	$\overline{\text{RAS}}$ cycling, $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$	—	100	—	90	—	80	mA	1, 2
Average Power Supply Current (Fast Page Mode)	$I_{CC7}$	$\overline{\text{RAS}} = V_{IL}$ , $\overline{\text{CAS}}$ cycling, $t_{PC} = \text{Min.}$	—	95	—	85	—	75	mA	1, 3
Average Power Supply Current (Battery Backup)	$I_{CC10}$	$t_{RC} = 125\text{ }\mu\text{s}$ , $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ , $t_{RAS} \leq 1\text{ }\mu\text{s}$	—	300	—	300	—	300	$\mu\text{A}$	1, 4, 5

- Notes :
1.  $I_{CC}$  Max. is specified as  $I_{CC}$  for output open condition.
  2. The address can be changed once or less while  $\overline{\text{RAS}} = V_{IL}$ .
  3. The address can be changed once or less while  $\overline{\text{CAS}} = V_{IH}$ .
  4.  $V_{CC} - 0.2\text{ V} \leq V_{IH} \leq 6.5\text{ V}$ ,  $-1.0\text{ V} \leq V_{IL} \leq 0.2\text{ V}$ .
  5. L-version.

AC Characteristics (1/2)

(V<sub>CC</sub> = 5 V ±10%, T<sub>a</sub> = 0°C to 70°C) Note 1, 2, 3

Parameter	Symbol	MSM511664 C/CL-60		MSM511664 C/CL-70		MSM511664 C/CL-80		Unit	Note
		Min.	Max.	Min.	Max.	Min.	Max.		
Random Read or Write Cycle Time	t <sub>RC</sub>	110	—	120	—	135	—	ns	
Read Modify Write Cycle Time	t <sub>RWC</sub>	155	—	170	—	185	—	ns	
Fast Page Mode Cycle Time	t <sub>PC</sub>	40	—	50	—	55	—	ns	
Fast Page Mode Read Modify Write Cycle Time	t <sub>PRWC</sub>	85	—	95	—	100	—	ns	
Access Time from $\overline{\text{RAS}}$	t <sub>RAC</sub>	—	60	—	70	—	80	ns	4, 5, 6
Access Time from $\overline{\text{CAS}}$	t <sub>CAC</sub>	—	20	—	25	—	30	ns	4, 5
Access Time from Column Address	t <sub>AA</sub>	—	30	—	40	—	45	ns	4, 6
Access Time from $\overline{\text{CAS}}$ Precharge	t <sub>CPA</sub>	—	35	—	45	—	50	ns	4
Access Time from $\overline{\text{OE}}$	t <sub>OEA</sub>	—	20	—	25	—	30	ns	4
Output Low Impedance Time from $\overline{\text{CAS}}$	t <sub>CLZ</sub>	0	—	0	—	0	—	ns	4
$\overline{\text{CAS}}$ to Data Output Buffer Turn-off Delay Time	t <sub>OFF</sub>	0	20	0	20	0	20	ns	7
$\overline{\text{OE}}$ to Data Output Buffer Turn-off Delay Time	t <sub>OEZ</sub>	0	15	0	15	0	15	ns	7
Transition Time	t <sub>T</sub>	3	50	3	50	3	50	ns	3
Refresh Period	t <sub>REF</sub>	—	4	—	4	—	4	ms	
Refresh Period (L-version)	t <sub>REF</sub>	—	32	—	32	—	32	ms	
$\overline{\text{RAS}}$ Precharge Time	t <sub>RP</sub>	40	—	40	—	45	—	ns	
$\overline{\text{RAS}}$ Pulse Width	t <sub>RAS</sub>	60	10,000	70	10,000	80	10,000	ns	
$\overline{\text{RAS}}$ Pulse Width (Fast Page Mode)	t <sub>RASP</sub>	60	100,000	70	100,000	80	100,000	ns	
$\overline{\text{RAS}}$ Hold Time	t <sub>RSH</sub>	20	—	25	—	30	—	ns	
$\overline{\text{RAS}}$ Hold Time referenced to $\overline{\text{OE}}$	t <sub>ROH</sub>	15	—	15	—	15	—	ns	
$\overline{\text{CAS}}$ Precharge Time (Fast Page Mode)	t <sub>CP</sub>	10	—	10	—	10	—	ns	
$\overline{\text{CAS}}$ Pulse Width	t <sub>CAS</sub>	20	10,000	25	10,000	30	10,000	ns	
$\overline{\text{CAS}}$ Hold Time	t <sub>CSH</sub>	60	—	70	—	80	—	ns	
$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ Precharge Time	t <sub>CRP</sub>	5	—	5	—	5	—	ns	
$\overline{\text{RAS}}$ Hold Time from $\overline{\text{CAS}}$ Precharge	t <sub>RHCP</sub>	35	—	45	—	50	—	ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Delay Time	t <sub>RCD</sub>	20	40	20	45	22	50	ns	5
$\overline{\text{RAS}}$ to Column Address Delay Time	t <sub>RAD</sub>	15	30	15	30	17	35	ns	6
Row Address Set-up Time	t <sub>ASR</sub>	0	—	0	—	0	—	ns	
Row Address Hold Time	t <sub>RAH</sub>	10	—	10	—	12	—	ns	
Column Address Set-up Time	t <sub>ASC</sub>	0	—	0	—	0	—	ns	
Column Address Hold Time	t <sub>CAH</sub>	10	—	10	—	15	—	ns	
Column Address Hold Time from $\overline{\text{RAS}}$	t <sub>AR</sub>	45	—	45	—	55	—	ns	
Column Address to $\overline{\text{RAS}}$ Lead Time	t <sub>RAL</sub>	30	—	40	—	45	—	ns	
Read Command Set-up Time	t <sub>RCS</sub>	0	—	0	—	0	—	ns	
Read Command Hold Time	t <sub>RCH</sub>	0	—	0	—	0	—	ns	8
Read Command Hold Time referenced to $\overline{\text{RAS}}$	t <sub>RRH</sub>	0	—	0	—	0	—	ns	8

**AC Characteristics (2/2)**

(V<sub>CC</sub> = 5 V ±10%, T<sub>a</sub> = 0°C to 70°C) Note 1, 2, 3

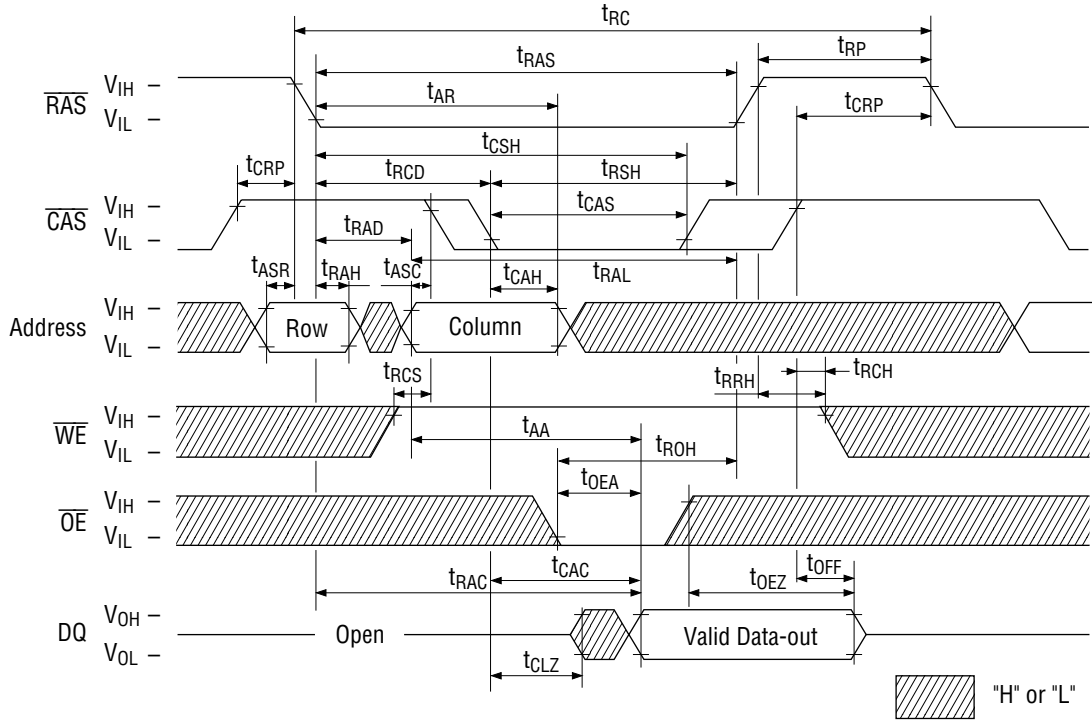
Parameter	Symbol	MSM511664 C/CL-60		MSM511664 C/CL-70		MSM511664 C/CL-80		Unit	Note
		Min.	Max.	Min.	Max.	Min.	Max.		
Write Command Set-up Time	t <sub>WCS</sub>	0	—	0	—	0	—	ns	9
Write Command Hold Time	t <sub>WCH</sub>	10	—	10	—	15	—	ns	
Write Command Hold Time from RAS	t <sub>WCR</sub>	40	—	45	—	55	—	ns	
Write Command Pulse Width	t <sub>WP</sub>	10	—	10	—	15	—	ns	
OE Command Hold Time	t <sub>OEH</sub>	10	—	10	—	10	—	ns	
Write Command to RAS Lead Time	t <sub>RWL</sub>	20	—	20	—	20	—	ns	
Write Command to CAS Lead Time	t <sub>CWL</sub>	20	—	20	—	20	—	ns	
Data-in Set-up Time	t <sub>DS</sub>	0	—	0	—	0	—	ns	10
Data-in Hold Time	t <sub>DH</sub>	10	—	10	—	15	—	ns	10
Data-in Hold Time from RAS	t <sub>DHR</sub>	40	—	45	—	55	—	ns	
OE to Data-in Delay Time	t <sub>OED</sub>	15	—	15	—	15	—	ns	
CAS to WE Delay Time	t <sub>CWD</sub>	40	—	50	—	55	—	ns	9
Column Address to WE Delay Time	t <sub>AWD</sub>	50	—	60	—	70	—	ns	9
RAS to WE Delay Time	t <sub>RWD</sub>	80	—	95	—	105	—	ns	9
CAS Precharge WE Delay Time	t <sub>CPWD</sub>	55	—	70	—	75	—	ns	9
CAS Active Delay Time from RAS Precharge	t <sub>RPC</sub>	0	—	0	—	0	—	ns	
RAS to CAS Set-up Time (CAS before RAS)	t <sub>CSR</sub>	5	—	5	—	5	—	ns	
RAS to CAS Hold Time (CAS before RAS)	t <sub>CHR</sub>	10	—	10	—	10	—	ns	

- Notes:
1. A start-up delay of  $100\ \mu\text{s}$  is required after power-up, followed by a minimum of eight initialization cycles ( $\overline{\text{RAS}}$ -only refresh or  $\overline{\text{CAS}}$  before  $\overline{\text{RAS}}$  refresh) before proper device operation is achieved.
  2. The AC characteristics assume  $t_T = 5\ \text{ns}$ .
  3.  $V_{IH}$  (Min.) and  $V_{IL}$  (Max.) are reference levels for measuring input timing signals. Transition times ( $t_T$ ) are measured between  $V_{IH}$  and  $V_{IL}$ .
  4. This parameter is measured with a load circuit equivalent to 1 TTL load and 50 pF.
  5. Operation within the  $t_{\text{RCD}}$  (Max.) limit ensures that  $t_{\text{RAC}}$  (Max.) can be met.  $t_{\text{RCD}}$  (Max.) is specified as a reference point only. If  $t_{\text{RCD}}$  is greater than the specified  $t_{\text{RCD}}$  (Max.) limit, then the access time is controlled by  $t_{\text{CAC}}$ .
  6. Operation within the  $t_{\text{RAD}}$  (Max.) limit ensures that  $t_{\text{RAC}}$  (Max.) can be met.  $t_{\text{RAD}}$  (Max.) is specified as a reference point only. If  $t_{\text{RAD}}$  is greater than the specified  $t_{\text{RAD}}$  (Max.) limit, then the access time is controlled by  $t_{\text{AA}}$ .
  7.  $t_{\text{OFF}}$  (Max.) and  $t_{\text{OEZ}}$  (Max.) define the time at which the output achieves the open circuit condition and are not referenced to output voltage levels.
  8.  $t_{\text{RCH}}$  or  $t_{\text{RRH}}$  must be satisfied for a read cycle.
  9.  $t_{\text{WCS}}$ ,  $t_{\text{CWD}}$ ,  $t_{\text{RWD}}$ ,  $t_{\text{AWD}}$  and  $t_{\text{CPWD}}$  are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only. If  $t_{\text{WCS}} \geq t_{\text{WCS}}$  (Min.), then the cycle is an early write cycle and the data out will remain open circuit (high impedance) throughout the entire cycle. If  $t_{\text{CWD}} \geq t_{\text{CWD}}$  (Min.),  $t_{\text{RWD}} \geq t_{\text{RWD}}$  (Min.),  $t_{\text{AWD}} \geq t_{\text{AWD}}$  (Min.) and  $t_{\text{CPWD}} \geq t_{\text{CPWD}}$  (Min.), then the cycle is a read modify write cycle and data out will contain data read from the selected cell; if neither of the above sets of conditions is satisfied, then the condition of the data out (at access time) is indeterminate.
  10. These parameters are referenced to the  $\overline{\text{CAS}}$  leading edge in an early write cycle, and to the  $\overline{\text{WE}}$  leading edge in an  $\overline{\text{OE}}$  control write cycle, or a read modify write cycle.

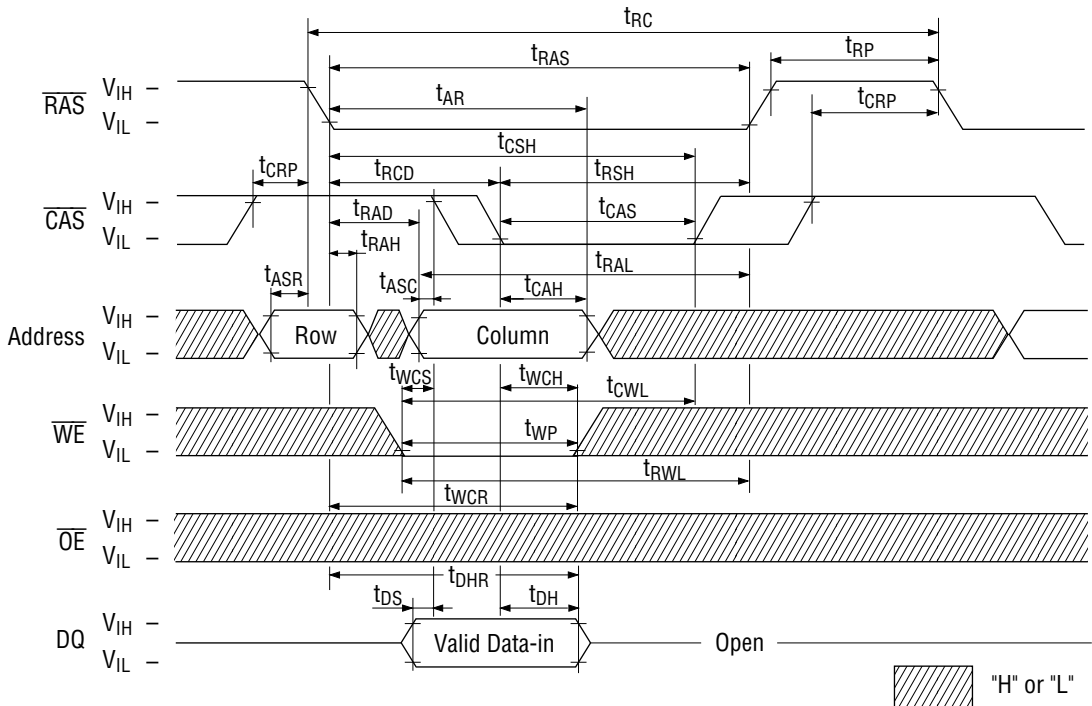


**TIMING WAVEFORM**

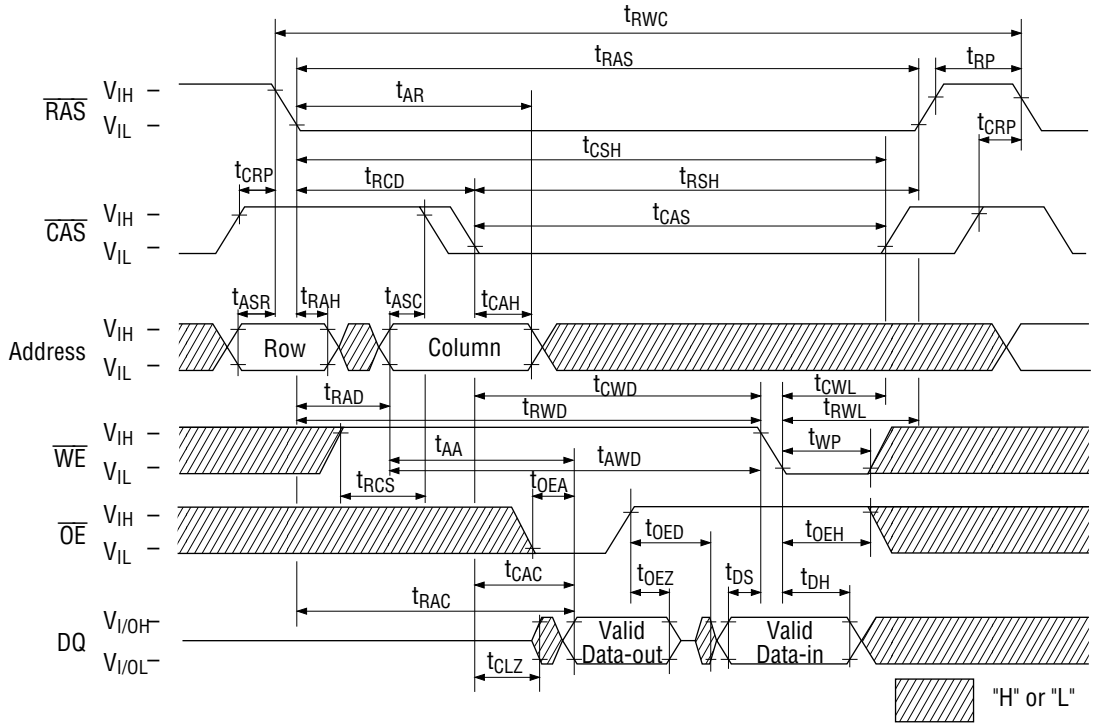
**Read Cycle**



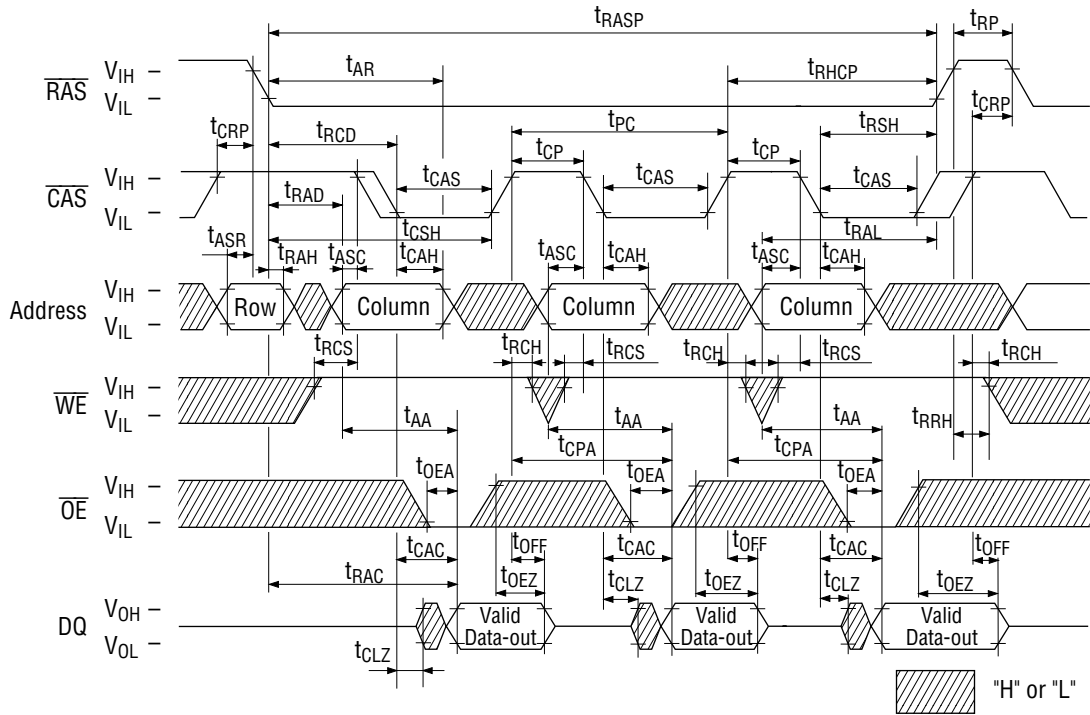
**Write Cycle (Early Write)**



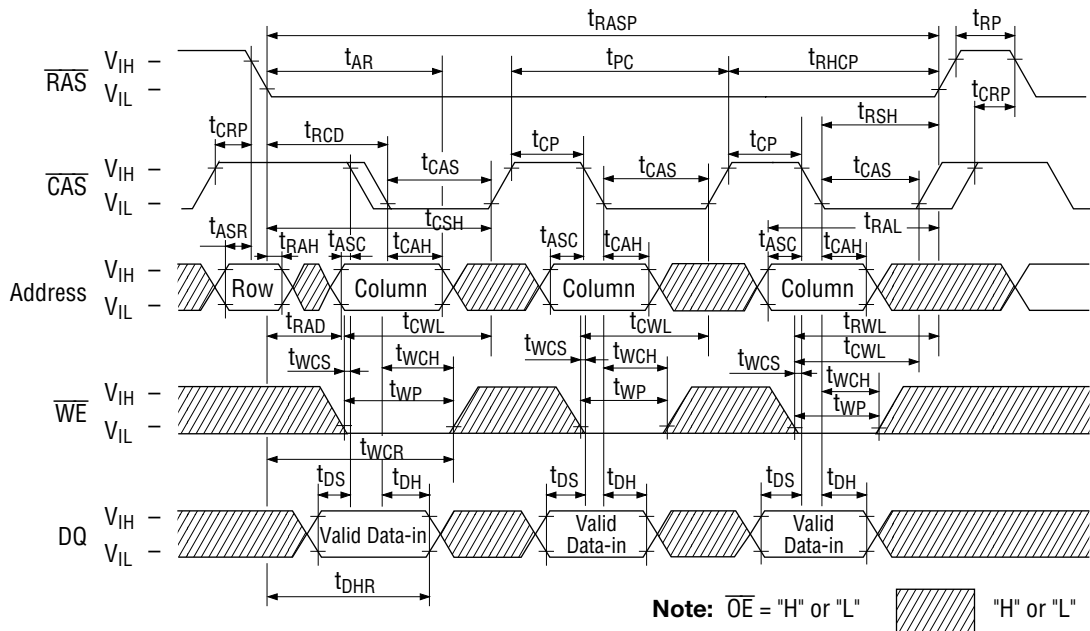
Read Modify Write Cycle



### Fast Page Mode Read Cycle

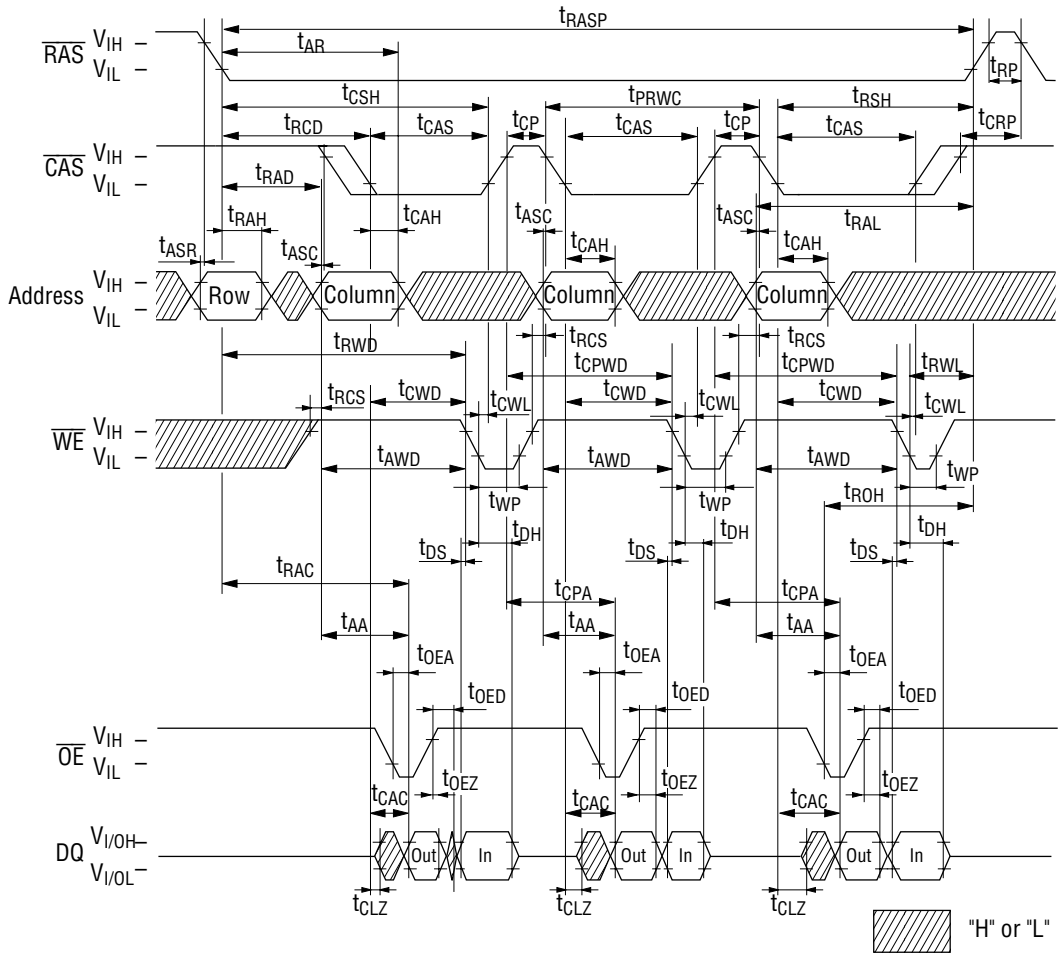


### Fast Page Mode Write Cycle (Early Write)

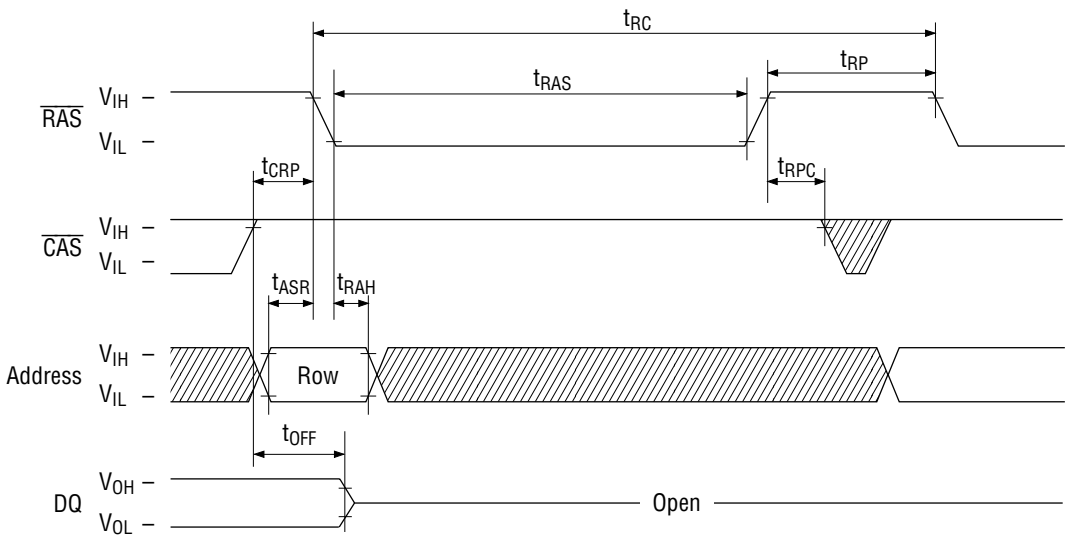


Note:  $\overline{OE}$  = "H" or "L"  "H" or "L"

**Fast Page Mode Read Modify Write Cycle**



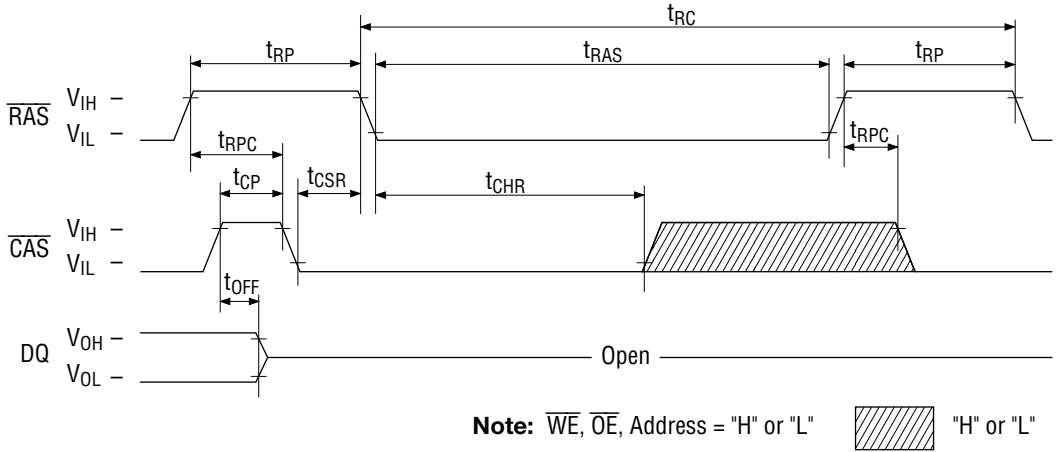
**RAS-Only Refresh Cycle**



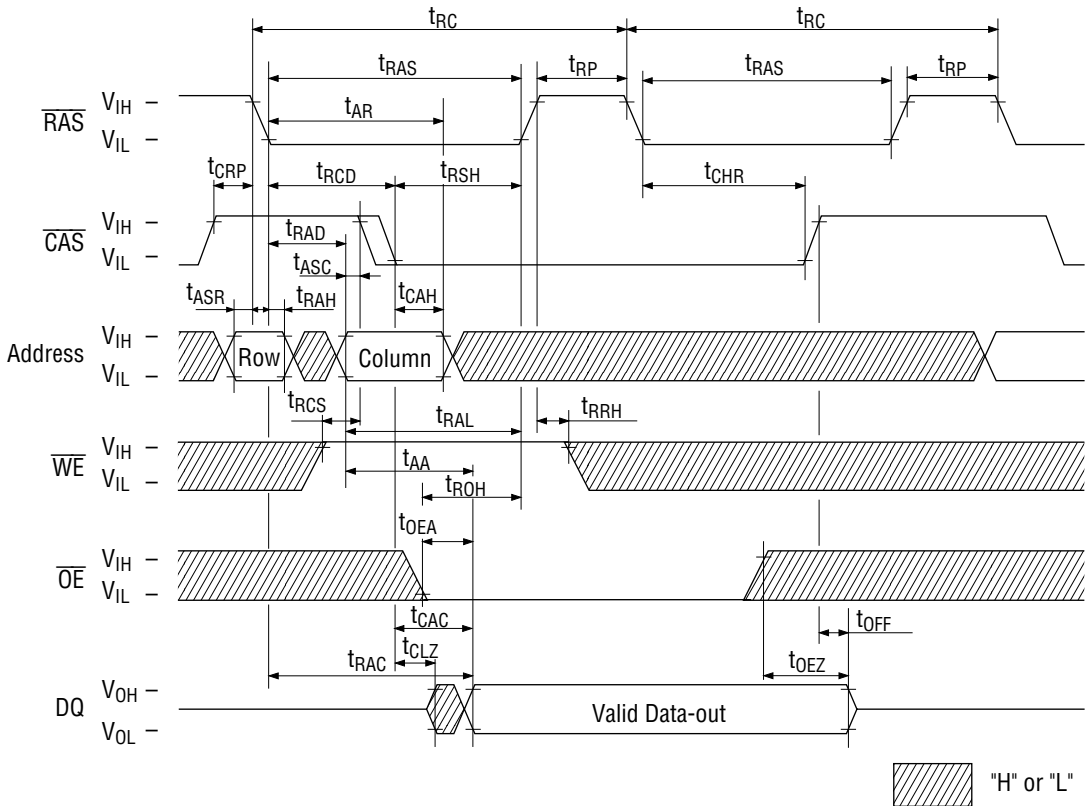
Note:  $\overline{WE}$ ,  $\overline{OE}$  = "H" or "L"

Legend: Shaded area = "H" or "L"

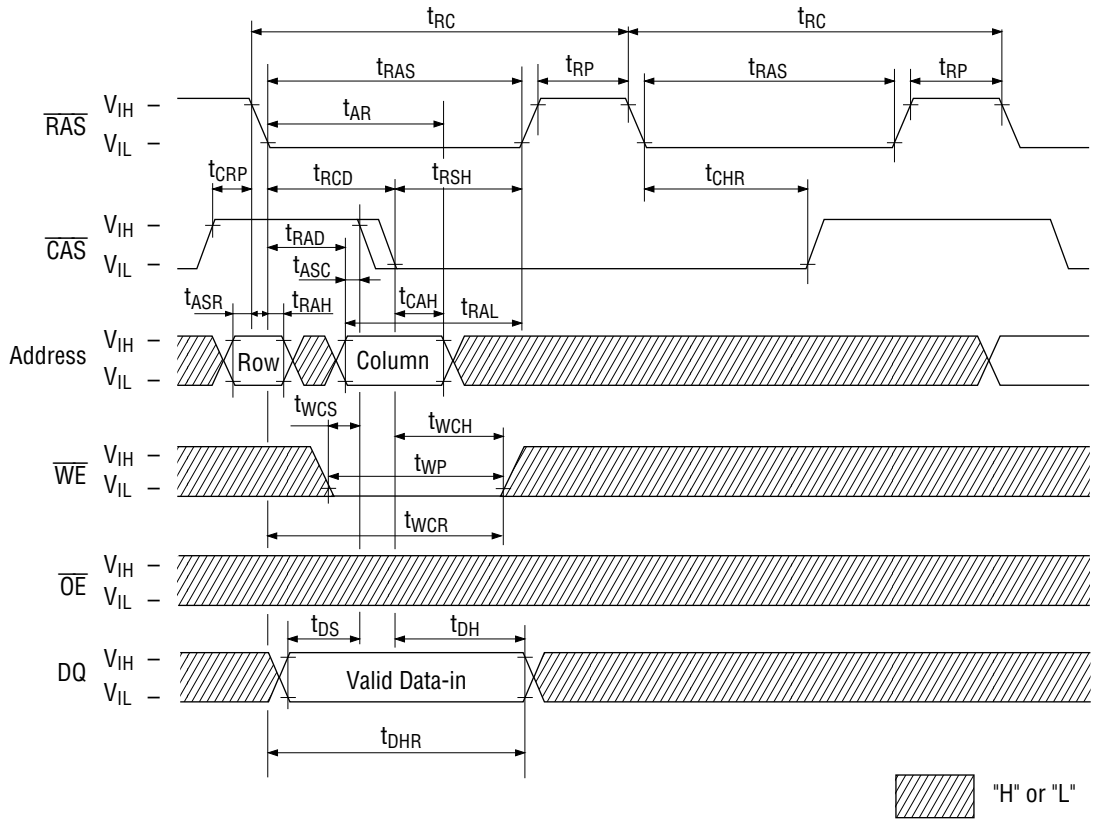
CAS before RAS Refresh Cycle



Hidden Refresh Read Cycle

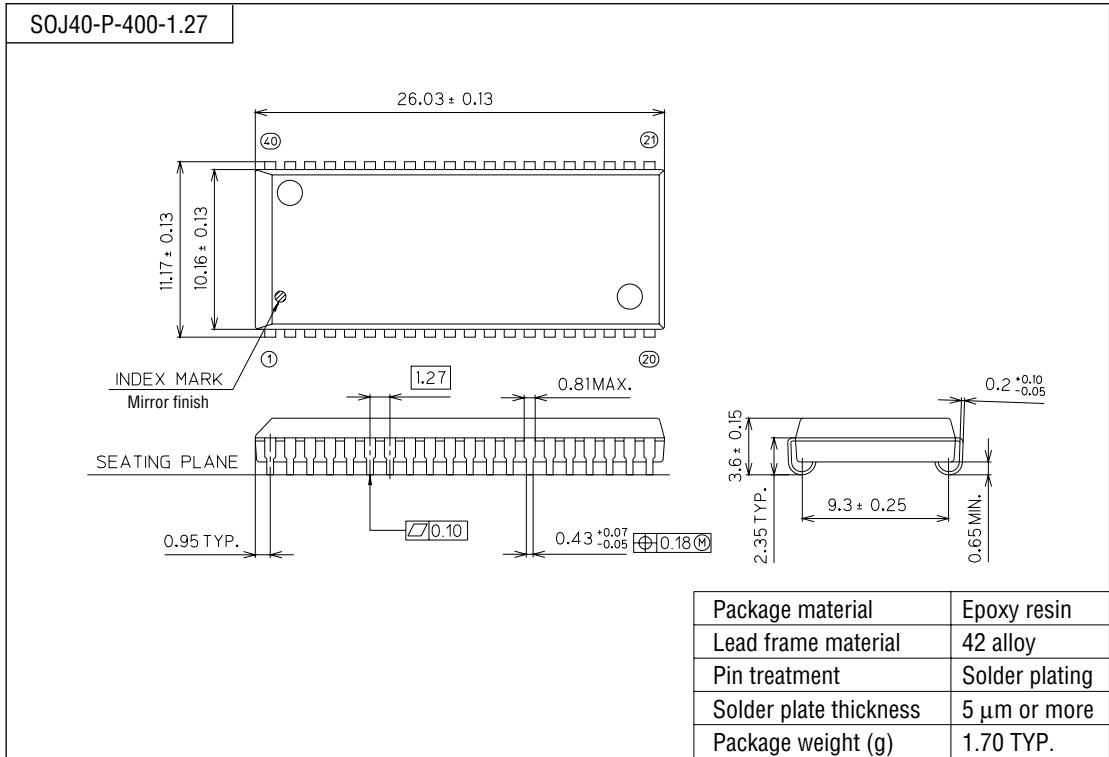


Hidden Refresh Write Cycle



**PACKAGE DIMENSIONS**

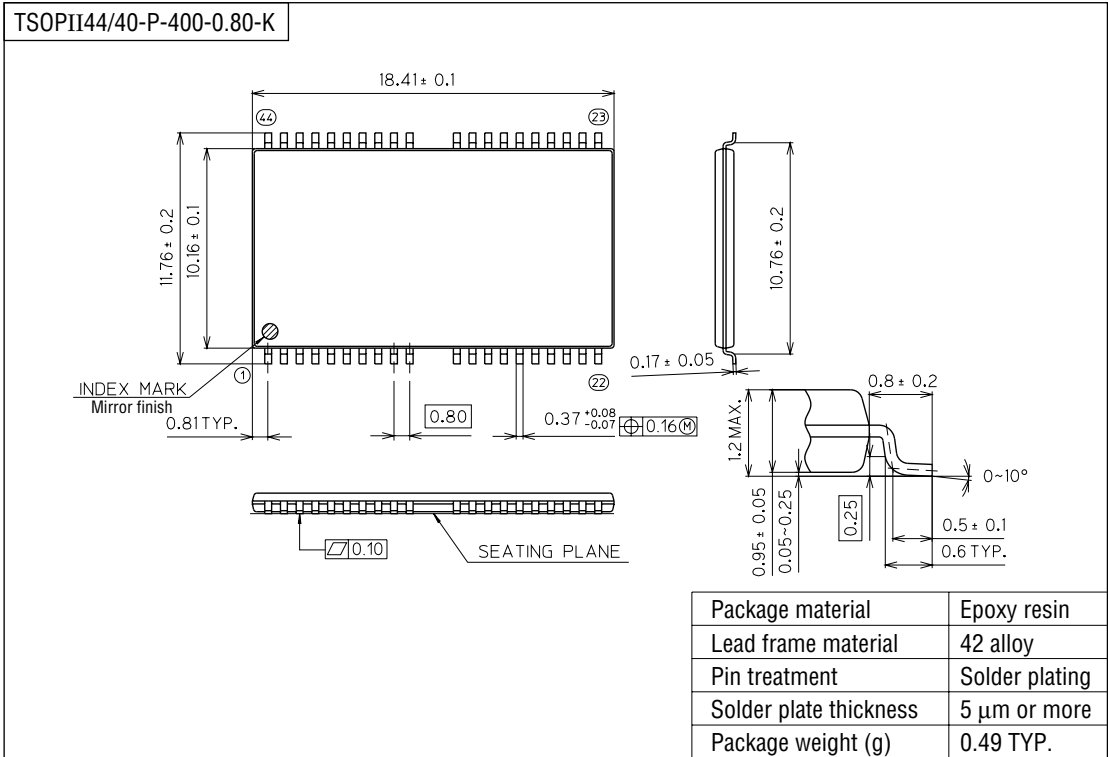
(Unit : mm)



**Notes for Mounting the Surface Mount Type Package**

The SOP, QFP, TSOP, SOJ, QFJ (PLCC), SHP and BGA are surface mount type packages, which are very susceptible to heat in reflow mounting and humidity absorbed in storage. Therefore, before you perform reflow mounting, contact Oki's responsible sales person for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

(Unit : mm)



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