OKI SEMICONDUCTOR

Dear customers,

About the change in the name such as "Oki Electric Industry Co. Ltd." and "OKI" in documents to OKI Semiconductor Co., Ltd.

The semiconductor business of Oki Electric Industry Co., Ltd. was succeeded to OKI Semiconductor Co., Ltd. on October 1, 2008. Therefore, please accept that although the terms and marks of "Oki Electric Industry Co., Ltd.", “Oki Electric”, and "OKI" remain in the documents, they all have been changed to "OKI Semiconductor Co., Ltd.". It is a change of the company name, the company trademark, and the logo, etc. , and NOT a content change in documents.

October 1, 2008
OKI Semiconductor Co., Ltd.

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OKI Semiconductor

FEDD51V16165F-03
Issue Date: Aug. 16, 2002

MSM51V16165F

1,048,576-Word × 16-Bit DYNAMIC RAM : FAST PAGE MODE TYPE WITH EDO

DESCRIPTION

The MSM51V16165F is a 1,048,576-word × 16-bit dynamic RAM fabricated in Oki's silicon-gate CMOS technology. The MSM51V16165F achieves high integration, high-speed operation, and low-power consumption because Oki manufactures the device in a quadruple-layer polysilicon/double-layer metal CMOS process. The MSM51V16165F is available in a 50/44-pin plastic TSOP.

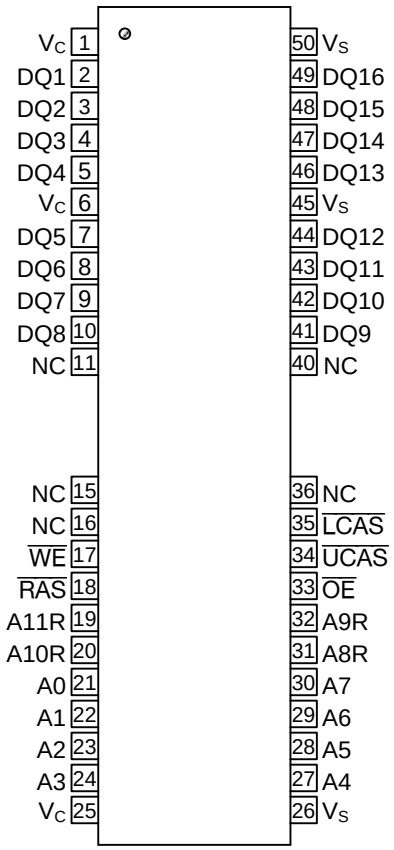
FEATURES

· 1,048,576-word × 16-bit configuration
· Single 3.3V power supply, ±0.3V tolerance
· Input : LVTTL compatible, low input capacitance
· Output : LVTTL compatible, 3-state
· Refresh : 4096 cycles/64ms
· Fast page mode with EDO, read modify write capability
· $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ refresh, hidden refresh, $\overline{\text{RAS}}$-only refresh capability
· Packages
50/44-pin 400mil plastic TSOP (TSOPII50/44-P-400-0.80-K) (Product : MSM51V16165F-xxTS-K)
xx indicates speed rank.

PRODUCT FAMILY

Family	Access Time (Max.)				Cycle Time (Min.)	Power Dissipation	
	t_{RAC}	t_{AA}	t_{CAC}	t_{OEA}		Operating (Max.)	Standby (Max.)
MSM51V16165F	50ns	25ns	13ns	13ns	84ns	270mW	1.8mW
	60ns	30ns	15ns	15ns	104ns	252mW	
	70ns	35ns	20ns	20ns	124ns	234mW	

PIN CONFIGURATION (TOP VIEW)

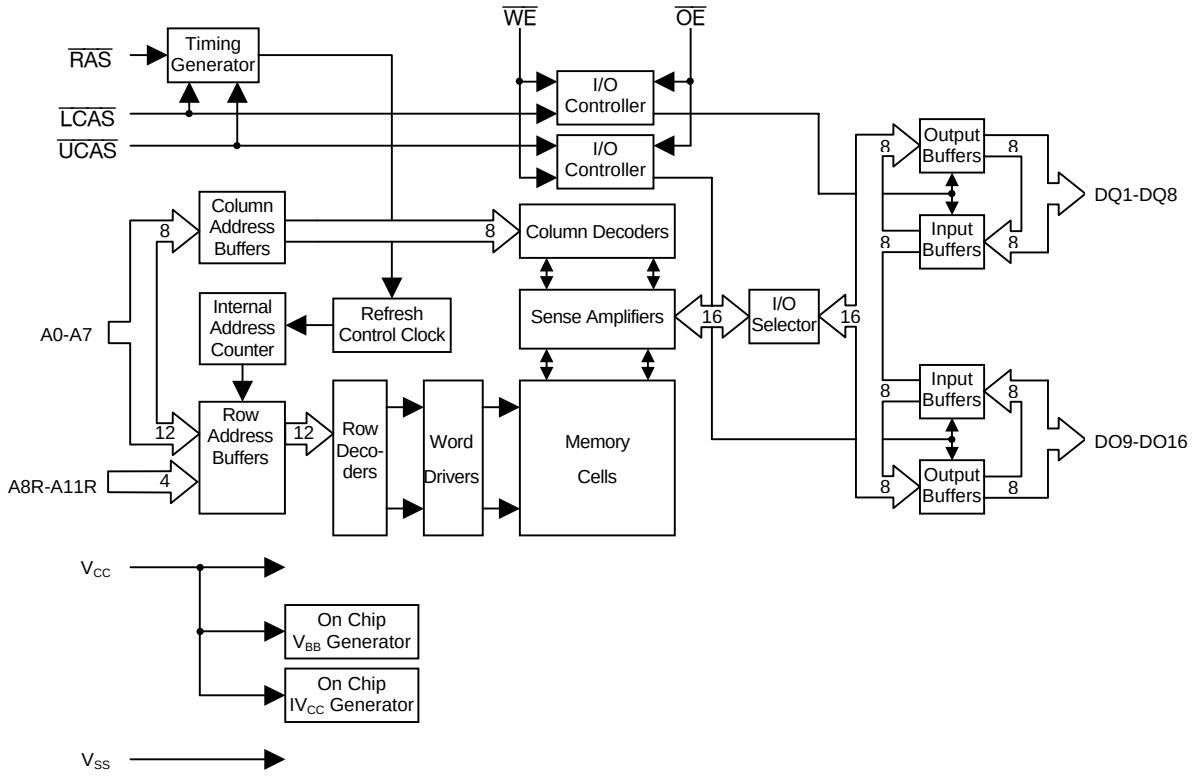


50/44-Pin Plastic TSOP
(K Type)

Pin Name	Function
A0–A7, A8R–A11R	Address Input
$\overline{RAS}$	Row Address Strobe
$\overline{LCAS}$	Lower Byte Column Address Strobe
$\overline{UCAS}$	Upper Byte Column Address Strobe
DQ1–DQ16	Data Input/Data Output
$\overline{OE}$	Output Enable
$\overline{WE}$	Write Enable
V_{CC}	Power Supply (3.3V)
V_{SS}	Ground (0V)
NC	No Connection

Note : The same power supply voltage must be provided to every V_{CC} pin, and the same GND voltage level must be provided to every V_{SS} pin.

BLOCK DIAGRAM



FUNCTION TABLE

Input Pin					DQ Pin		Function Mode
$\overline{RAS}$	$\overline{LCAS}$	$\overline{UCAS}$	$\overline{WE}$	$\overline{OE}$	DQ1-DQ8	DQ9-DQ16	
H	*	*	*	*	High-Z	High-Z	Standby
L	H	H	*	*	High-Z	High-Z	Refresh
L	L	H	H	L	D_{OUT}	High-Z	Lower Byte Read
L	H	L	H	L	High-Z	D_{OUT}	Upper Byte Read
L	L	L	H	L	D_{OUT}	D_{OUT}	Word Read
L	L	H	L	H	D_{IN}	Don't Care	Lower Byte Write
L	H	L	L	H	Don't Care	D_{IN}	Upper Byte Write
L	L	L	L	H	D_{IN}	D_{IN}	Word Write
L	L	L	H	H	High-Z	High-Z	—

* : "H" or "L"

ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Value	Unit
Voltage on Any Pin Relative to V_{SS}	V_{IN}, V_{OUT}	–0.5 to V_{CC}+0.5	V
Voltage V_{CC} Supply relative to V_{SS}	V_{CC}	–0.5 to 4.6	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

*: Ta = 25°C

RECOMMENDED OPERATING CONDITIONS

(Ta = 0 to 70°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power Supply Voltage	V_{CC}	3.0	3.3	3.6	V
	V_{SS}	0	0	0	V
Input High Voltage	V_{IH}	2.0	—	V_{CC} + 0.3[*1]	V
Input Low Voltage	V_{IL}	– 0.3[*2]	—	0.8	V

Notes: *1. The input voltage is V_{CC} + 1.0V when the pulse width is less than 20ns (the pulse width is with respect to the point at which V_{CC} is applied).

*2. The input voltage is V_{SS} – 1.0V when the pulse width is less than 20ns (the pulse width respect to the point at which V_{SS} is applied).

PIN CAPACITANCE

(Vcc = 3.3V ± 0.3V, Ta = 25°C, f = 1 MHz)

Parameter	Symbol	Min.	Max.	Unit
Input Capacitance (A0 – A7, A8R – A11R)	C_{IN1}	—	5	pF
Input Capacitance ($\overline{RAS}$, $\overline{LCAS}$, $\overline{UCAS}$, $\overline{WE}$, $\overline{OE}$)	C_{IN2}	—	7	pF
Output Capacitance (DQ1 - DQ16)	$C_{I/O}$	—	7	pF

DC CHARACTERISTICS

(V_{CC} = 3.3V ± 0.3V, Ta = 0 to 70°C)

Parameter	Symbol	Condition	MSM51V16165 F-50		MSM51V16165 F-60		MSM51V16165 F-70		Unit	Note
			Min.	Max.	Min.	Max.	Min.	Max.		
Output High Voltage	V_{OH}	I_{OH} = –2.0mA	2.4	V_{CC}	2.4	V_{CC}	2.4	V_{CC}	V	
Output Low Voltage	V_{OL}	I_{OL} = 2mA	0	0.4	0	0.4	0	0.4	V	
Input Leakage Current	I_{LI}	0V ≤ V_I ≤ V_{CC}+0.3V; All other pins not under test = 0V	– 10	10	– 10	10	– 10	10	μA	
Output Leakage Current	I_{LO}	DQ disable 0V ≤ V_O ≤ V_{CC}	– 10	10	– 10	10	– 10	10	μA	
Average Power Supply Current (Operating)	I_{CC1}	$\overline{RAS}$, $\overline{CAS}$ cycling, t_{RC} = Min.	—	75	—	70	—	65	mA	1,2
Power Supply Current (Standby)	I_{CC2}	$\overline{RAS}$, $\overline{CAS}$ = V_{IH}	—	2	—	2	—	2	mA	1
		$\overline{RAS}$, $\overline{CAS}$ ≥ V_{CC} – 0.2V	—	0.5	—	0.5	—	0.5		
Average Power Supply Current ($\overline{RAS}$-only Refresh)	I_{CC3}	$\overline{RAS}$ cycling, $\overline{CAS}$ = V_{IH}, t_{RC} = Min.	—	75	—	70	—	65	mA	1,2
Power Supply Current (Standby)	I_{CC5}	$\overline{RAS}$ = V_{IH}, $\overline{CAS}$ = V_{IL}, DQ = enable	—	5	—	5	—	5	mA	1
Average Power Supply Current ($\overline{CAS}$ before $\overline{RAS}$ Refresh)	I_{CC6}	$\overline{RAS}$ = cycling, $\overline{CAS}$ before $\overline{RAS}$	—	75	—	70	—	65	mA	1,2
Average Power Supply Current (Fast Page Mode)	I_{CC7}	$\overline{RAS}$ = V_{IL}, $\overline{CAS}$ cycling, t_{HPC} = Min.	—	75	—	70	—	65	mA	1,3

Notes: 1. I_{CC} Max. is specified as I_{CC} for output open condition.
2. The address can be changed once or less while $\overline{RAS}$ = V_{IL}.
3. The address can be changed once or less while $\overline{CAS}$ = V_{IH}.

AC CHARACTERISTICS (1/2)

(V_{CC} = 3.3V ± 0.3V, Ta = 0 to 70°C) Note1,2,3

Parameter	Symbol	MSM51V16165 F-50		MSM51V16165 F-60		MSM51V16165 F-70		Unit	Note
		Min.	Max.	Min.	Max.	Min.	Max.		
Random Read or Write Cycle Time	t_{RC}	84	—	104	—	124	—	ns	
Read Modify Write Cycle Time	t_{RWC}	110	—	135	—	160	—	ns	
Fast Page Mode Cycle Time	t_{HPC}	20	—	25	—	30	—	ns	
Fast Page Mode Read Modify Write Cycle Time	t_{HPRWC}	58	—	68	—	78	—	ns	
Access Time from $\overline{RAS}$	t_{RAC}	—	50	—	60	—	70	ns	4, 5, 6
Access Time from $\overline{CAS}$	t_{CAC}	—	13	—	15	—	20	ns	4,5
Access Time from Column Address	t_{AA}	—	25	—	30	—	35	ns	4,6
Access Time from $\overline{CAS}$ Precharge	t_{CPA}	—	30	—	35	—	40	ns	4,13
Access Time from $\overline{OE}$	t_{OEA}	—	13	—	15	—	20	ns	4
Output Low Impedance Time from $\overline{CAS}$	t_{CLZ}	0	—	0	—	0	—	ns	4
Data Output Hold After $\overline{CAS}$ Low	t_{DOH}	5	—	5	—	5	—	ns	
$\overline{CAS}$ to Data Output Buffer Turn-off Delay Time	t_{CEZ}	0	13	0	15	0	20	ns	7,8
$\overline{RAS}$ to Data Output Buffer Turn-off Delay Time	t_{REZ}	0	13	0	15	0	20	ns	7,8
$\overline{OE}$ to Data Output Buffer Turn-off Delay Time	t_{OEZ}	0	13	0	15	0	20	ns	7
$\overline{WE}$ to Data Output Buffer Turn-off Delay Time	t_{WEZ}	0	13	0	15	0	20	ns	7
Transition Time	t_T	1	50	1	50	1	50	ns	3
Refresh Period	t_{REF}	—	64	—	64	—	64	ms	
$\overline{RAS}$ Precharge Time	t_{RP}	30	—	40	—	50	—	ns	
$\overline{RAS}$ Pulse Width	t_{RAS}	50	10,000	60	10,000	70	10,000	ns	
$\overline{RAS}$ Pulse Width (Fast Page Mode with EDO)	t_{RASP}	50	100,000	60	100,000	70	100,000	ns	
$\overline{RAS}$ Hold Time	t_{RSH}	7	—	10	—	13	—	ns	
$\overline{RAS}$ Hold Time referenced to $\overline{OE}$	t_{ROH}	7	—	10	—	13	—	ns	
$\overline{CAS}$ Precharge Time (Fast Page Mode with EDO)	t_{CP}	7	—	10	—	10	—	ns	15
$\overline{CAS}$ Pulse Width	t_{CAS}	7	10,000	10	10,000	13	10,000	ns	
$\overline{CAS}$ Hold Time	t_{CSH}	35	—	40	—	45	—	ns	
$\overline{CAS}$ to $\overline{RAS}$ Precharge Time	t_{CRP}	5	—	5	—	5	—	ns	13
$\overline{RAS}$ Hold Time from $\overline{CAS}$ Precharge	t_{RHCP}	30	—	35	—	40	—	ns	13

AC CHARACTERISTICS (2/2)

(V_{CC} = 3.3V ± 0.3V, Ta = 0 to 70°C) Note1,2,3

Parameter	Symbol	MSM51V16165 F-50		MSM51V16165 F-60		MSM51V16165 F-70		Unit	Note
		Min.	Max.	Min.	Max.	Min.	Max.		
$\overline{OE}$ Hold Time from $\overline{CAS}$ (DQ Disable)	t_{CHO}	5	—	5	—	5	—	ns	
$\overline{RAS}$ to $\overline{CAS}$ Delay Time	t_{RCD}	11	37	14	45	14	50	ns	5
$\overline{RAS}$ to Column Address Delay Time	t_{RAD}	9	25	12	30	12	35	ns	6
Row Address Set-up Time	t_{ASR}	0	—	0	—	0	—	ns	
Row Address Hold Time	t_{RAH}	7	—	10	—	10	—	ns	
Column Address Set-up Time	t_{ASC}	0	—	0	—	0	—	ns	12
Column Address Hold Time	t_{CAH}	7	—	10	—	13	—	ns	12
Column Address to $\overline{RAS}$ Lead Time	t_{RAL}	25	—	30	—	35	—	ns	
Read Command Set-up Time	t_{RCS}	0	—	0	—	0	—	ns	12
Read Command Hold Time	t_{RCH}	0	—	0	—	0	—	ns	9,12
Read Command Hold Time referenced to $\overline{RAS}$	t_{RRH}	0	—	0	—	0	—	ns	9
Write Command Set-up Time	t_{WCS}	0	—	0	—	0	—	ns	10,12
Write Command Hold Time	t_{WCH}	7	—	10	—	13	—	ns	12
Write Command Pulse Width	t_{WP}	7	—	10	—	10	—	ns	
$\overline{WE}$ Pulse Width (DQ Disable)	t_{WPE}	7	—	10	—	10	—	ns	
$\overline{OE}$ Command Hold Time	t_{OEH}	7	—	10	—	13	—	ns	
$\overline{OE}$ Precharge Time	t_{OEP}	7	—	10	—	10	—	ns	
$\overline{OE}$ Command Hold Time	t_{OCH}	7	—	10	—	10	—	ns	
Write Command to $\overline{RAS}$ Lead Time	t_{RWL}	7	—	10	—	13	—	ns	
Write Command to $\overline{CAS}$ Lead Time	t_{CWL}	7	—	10	—	13	—	ns	14
Data-in Set-up Time	t_{DS}	0	—	0	—	0	—	ns	11,12
Data-in Hold Time	t_{DH}	7	—	10	—	13	—	ns	11,12
$\overline{OE}$ to Data-in Delay Time	t_{OED}	13	—	15	—	20	—	ns	
$\overline{CAS}$ to $\overline{WE}$ Delay Time	t_{CWD}	30	—	34	—	44	—	ns	10
Column Address to $\overline{WE}$ Delay Time	t_{AWD}	42	—	49	—	59	—	ns	10
$\overline{RAS}$ to $\overline{WE}$ Delay Time	t_{RWD}	67	—	79	—	94	—	ns	10
$\overline{CAS}$ Precharge $\overline{WE}$ Delay Time	t_{CPWD}	47	—	54	—	64	—	ns	10
$\overline{CAS}$ Active Delay Time from $\overline{RAS}$ Precharge	t_{RPC}	5	—	5	—	5	—	ns	12
$\overline{RAS}$ to $\overline{CAS}$ Set-up Time ($\overline{CAS}$ before $\overline{RAS}$)	t_{CSR}	5	—	5	—	5	—	ns	12
$\overline{RAS}$ to $\overline{CAS}$ Hold Time ($\overline{CAS}$ before $\overline{RAS}$)	t_{CHR}	10	—	10	—	10	—	ns	13

Notes: 1. A start-up delay of 200μs is required after power-up, followed by a minimum of eight initialization cycles ($\overline{RAS}$-only refresh or $\overline{CAS}$ before $\overline{RAS}$ refresh) before proper device operation is achieved.

2. The AC characteristics assume t_T = 2ns.

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. -50 is measured with a load circuit equivalent to 1 TTL load and 50pF, and -60/-70 is measured with a load circuit equivalent to 1 TTL load and 100pF.
The output timing reference levels are V_{OH}=2.0 and V_{OL}=0.8V.

5. Operation within the t_{RCD} (Max.) limit ensures that t_{RAC} (Max.) can be met.
t_{RCD} (Max.) is specified as a reference point only. If t_{RCD} is greater than the specified t_{RCD} (Max.) limit, then the access time is controlled by t_{CAC}.

6. Operation within the t_{RAD} (Max.) limit ensures that t_{RAC} (Max.) can be met.
t_{RAD} (Max.) is specified as a reference point only. If t_{RAD} is greater than the specified t_{RAD} (Max.) limit, then the access time is controlled by t_{AA}.

7. t_{CEZ} (Max.), t_{REZ} (Max.), t_{WEZ} (Max.), and t_{OEZ} (Max.) define the time at which the output achieved the open circuit condition and are not referenced to output voltage levels.

8. t_{CEZ}, and t_{REZ} must be satisfied for open circuit condition.

9. t_{RCH} or t_{RRH} must be satisfied for a read cycle.

10. t_{WCS}, t_{CWD}, t_{RWD}, t_{AWD} and t_{CPWD} are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only. If $t_{WCS} \geq t_{WCS}$ (Min.), then the cycle is an early write cycle and the data out will remain open circuit (high impedance) throughout the entire cycle. If $t_{CWD} \geq t_{CWD}$ (Min.), $t_{RWD} \geq t_{RWD}$(Min.), $t_{AWD} \geq t_{AWD}$ (Min.) and $t_{CPWD} \geq t_{CPWD}$ (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.

11. These parameters are referenced to the $\overline{UCAS}$ and $\overline{LCAS}$, leading edges in an early write cycle, and to the $\overline{WE}$ leading edge in an $\overline{OE}$ control write cycle, or a read modify write cycle.

12. These parameters are determined by the falling edge of either $\overline{UCAS}$ or $\overline{LCAS}$, whichever is earlier.

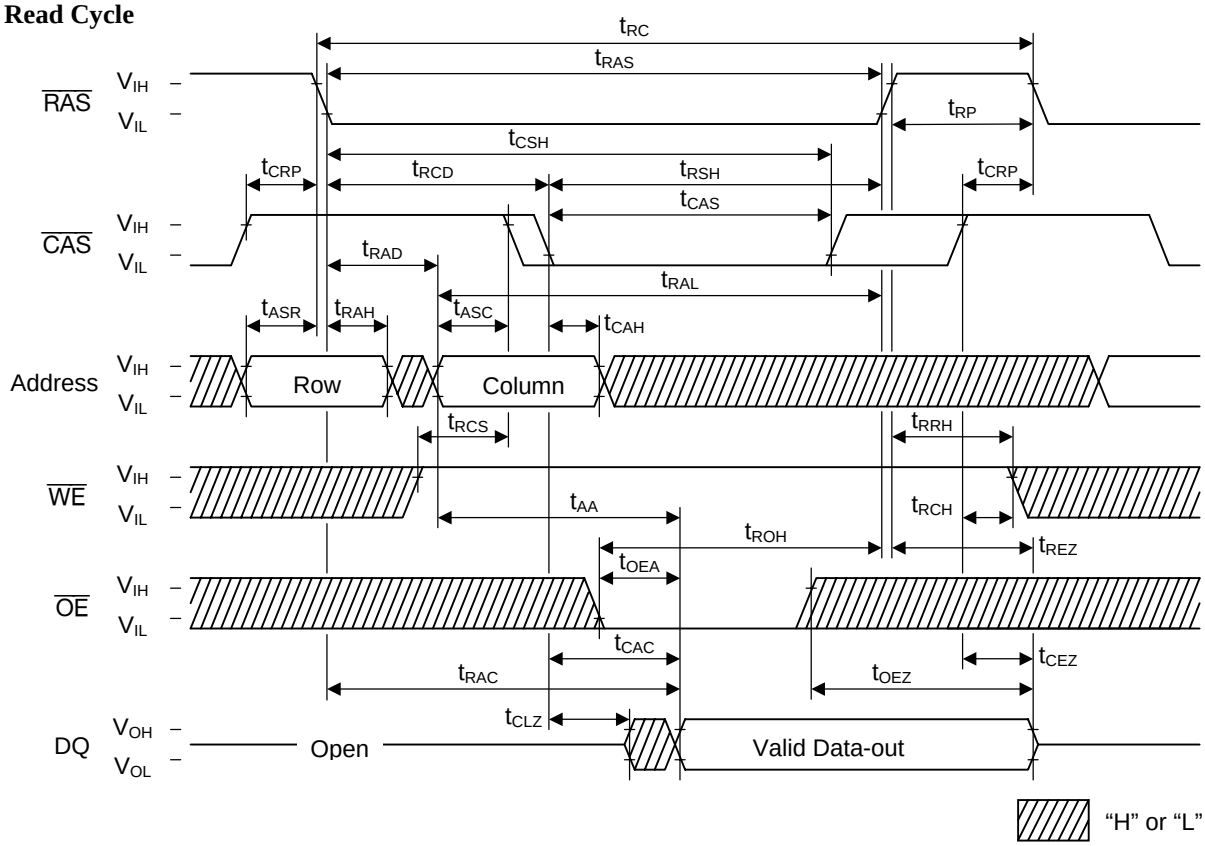
13. These parameters are determined by the rising edge of either $\overline{UCAS}$ or $\overline{LCAS}$, whichever is later.

14. t_{CWL} should be satisfied by both $\overline{UCAS}$ and $\overline{LCAS}$.

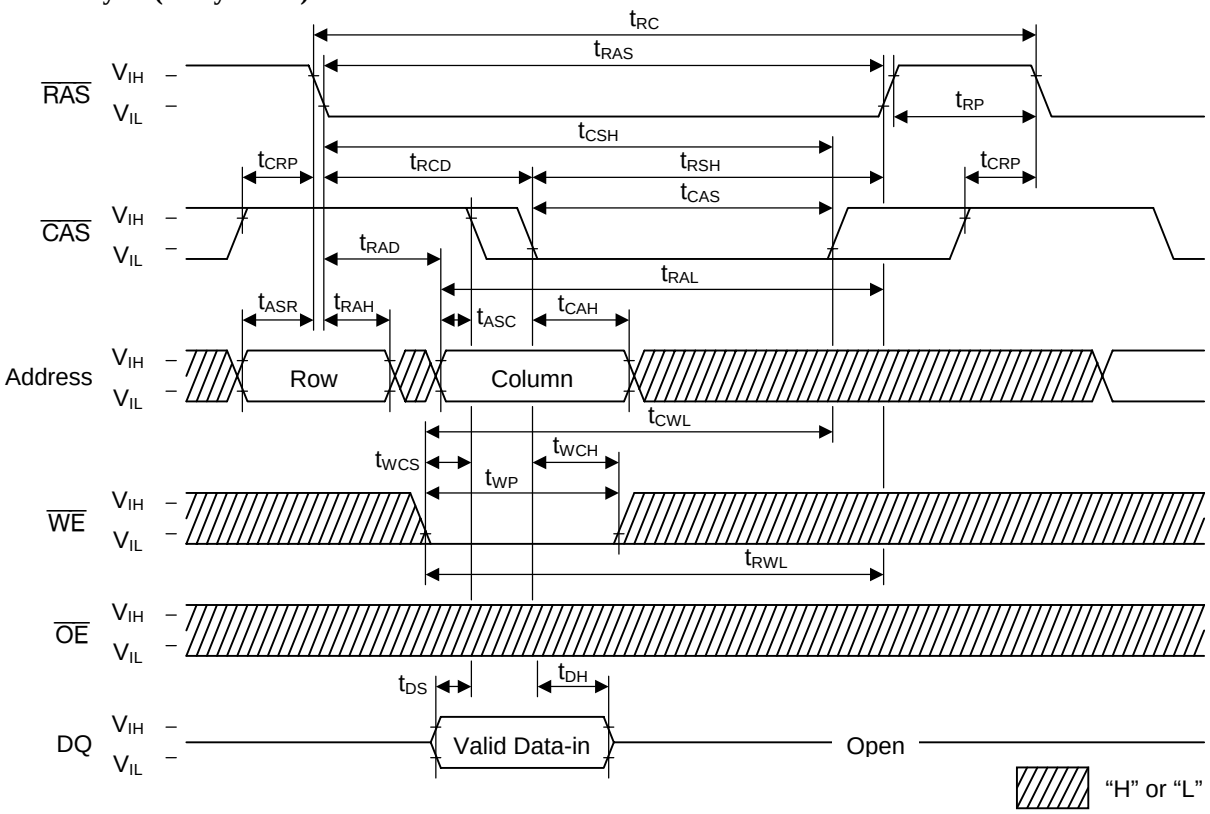
15. t_{CP} is determined by the time both $\overline{UCAS}$ and $\overline{LCAS}$ are high.

TIMING CHART

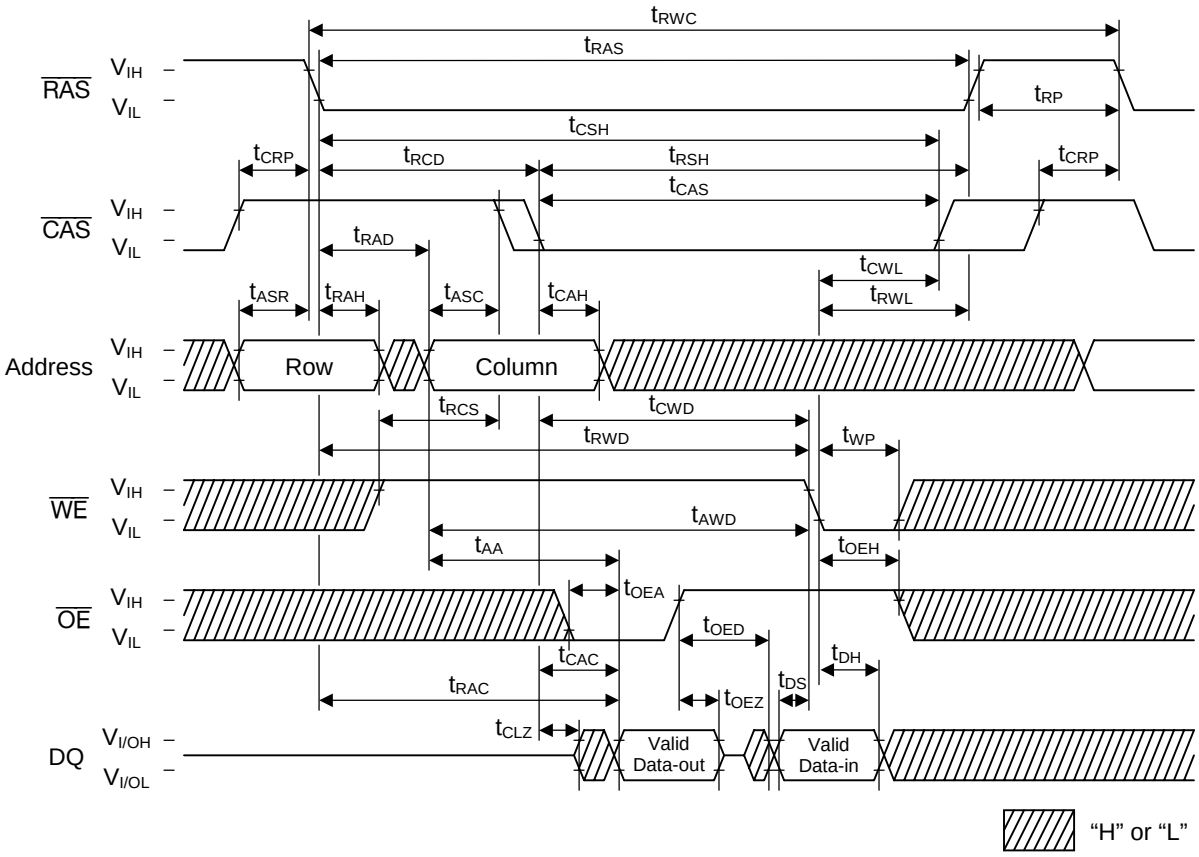
Read Cycle



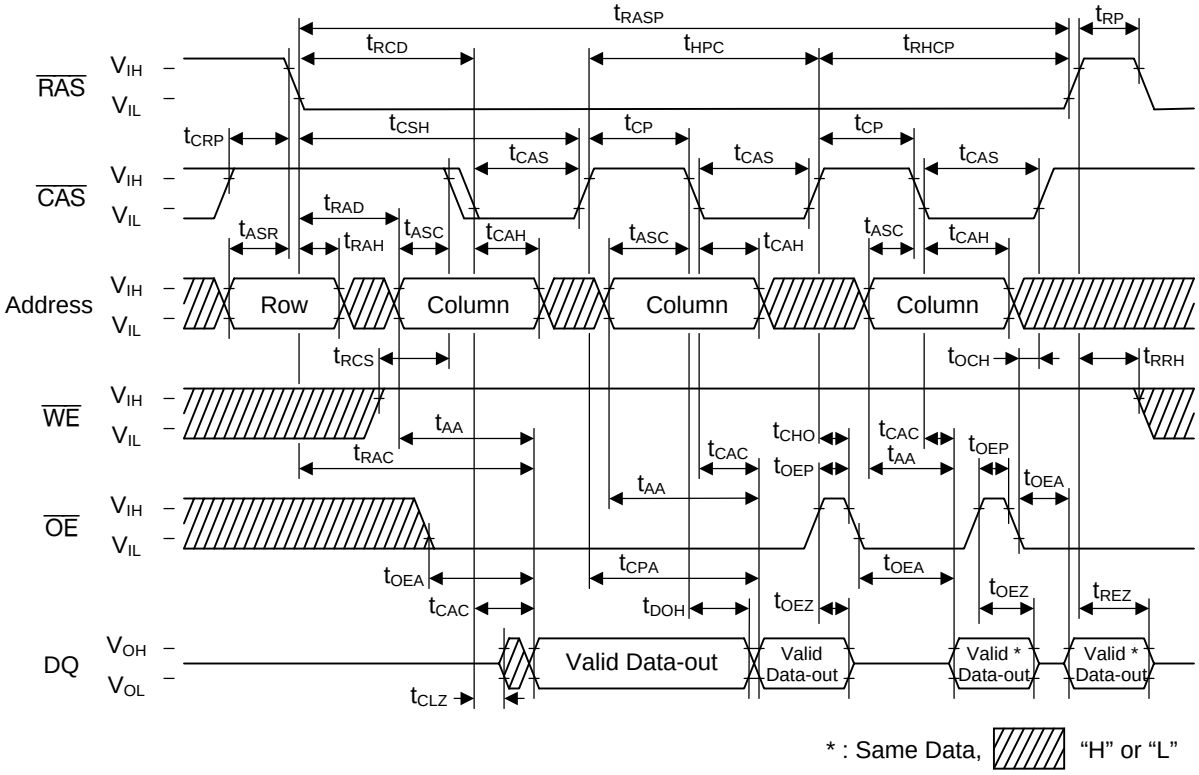
Write Cycle (Early Write)



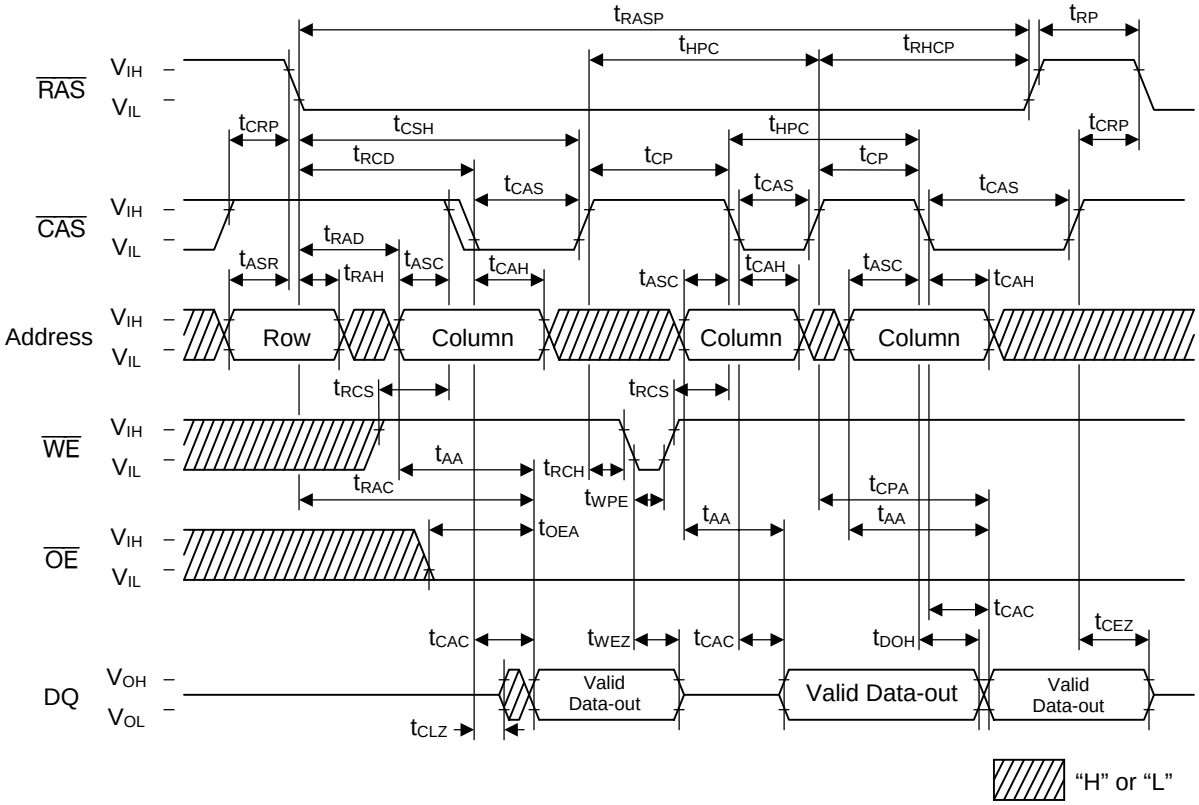
Read Modify Write Cycle



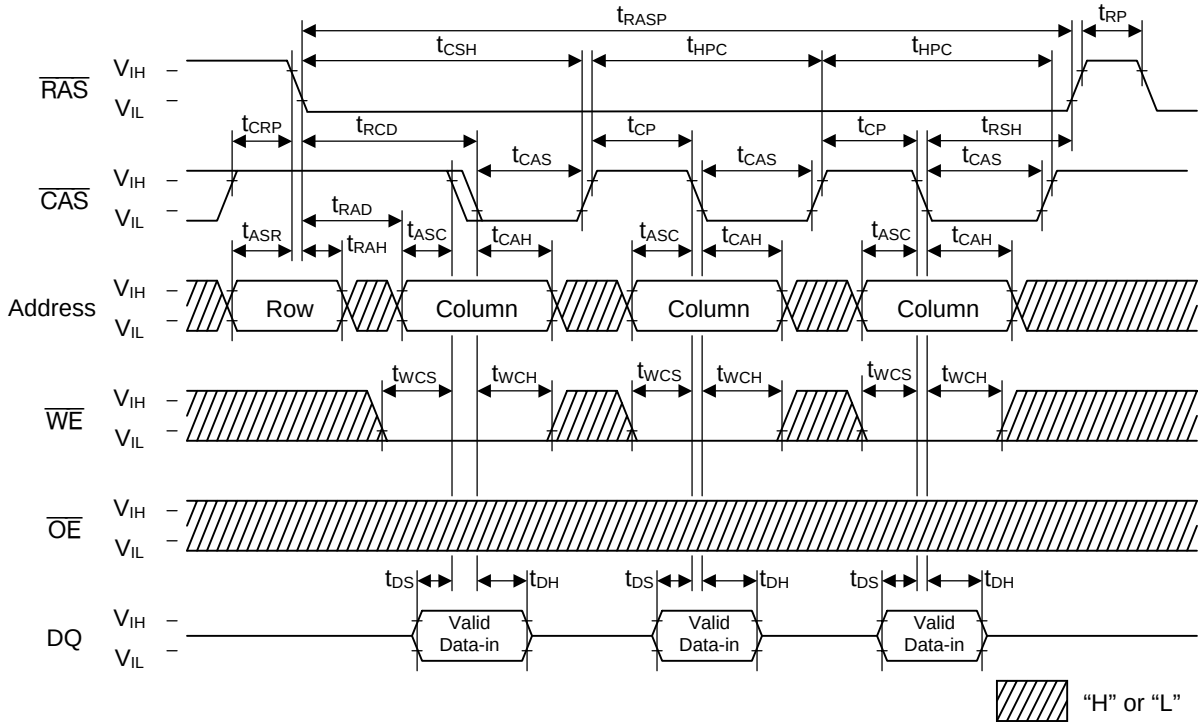
Fast Page Mode Read Cycle (Part-1)



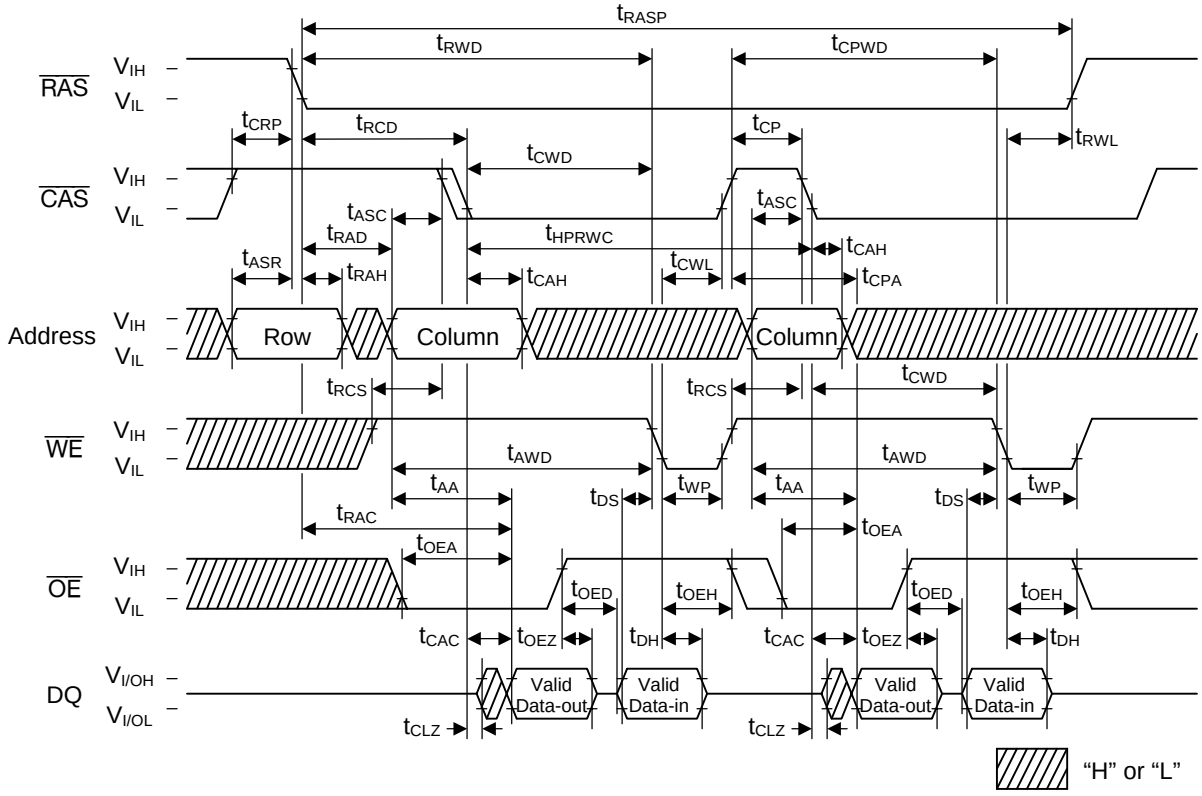
Fast Page Mode Read Cycle (Part-2)



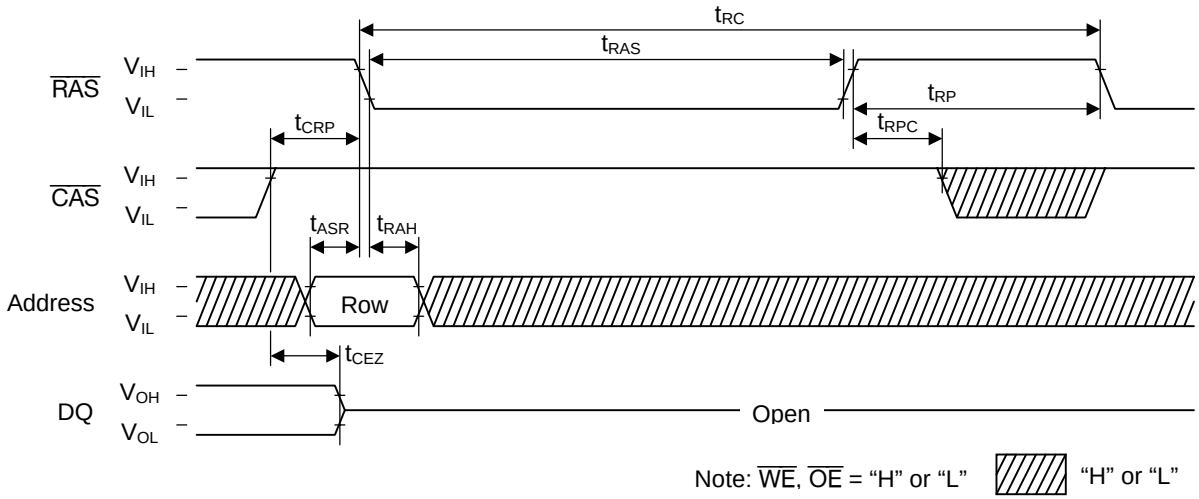
Fast Page Mode Write Cycle (Early Write)



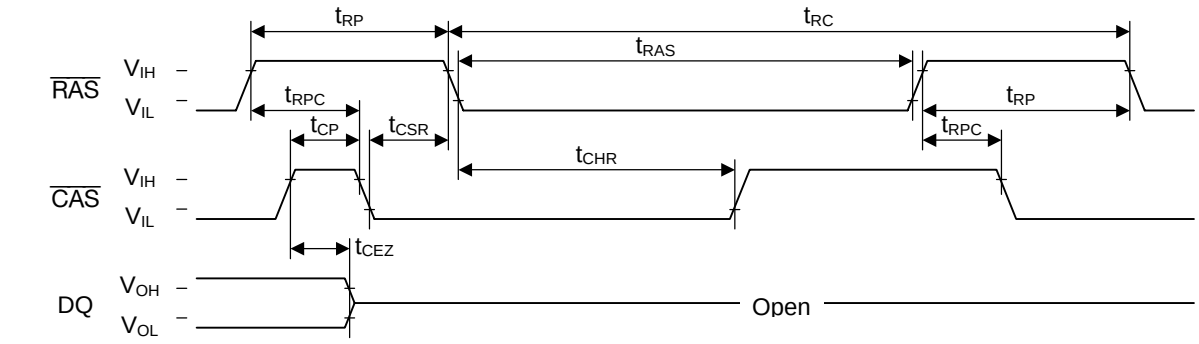
Fast Page Mode Read Modify Write Cycle



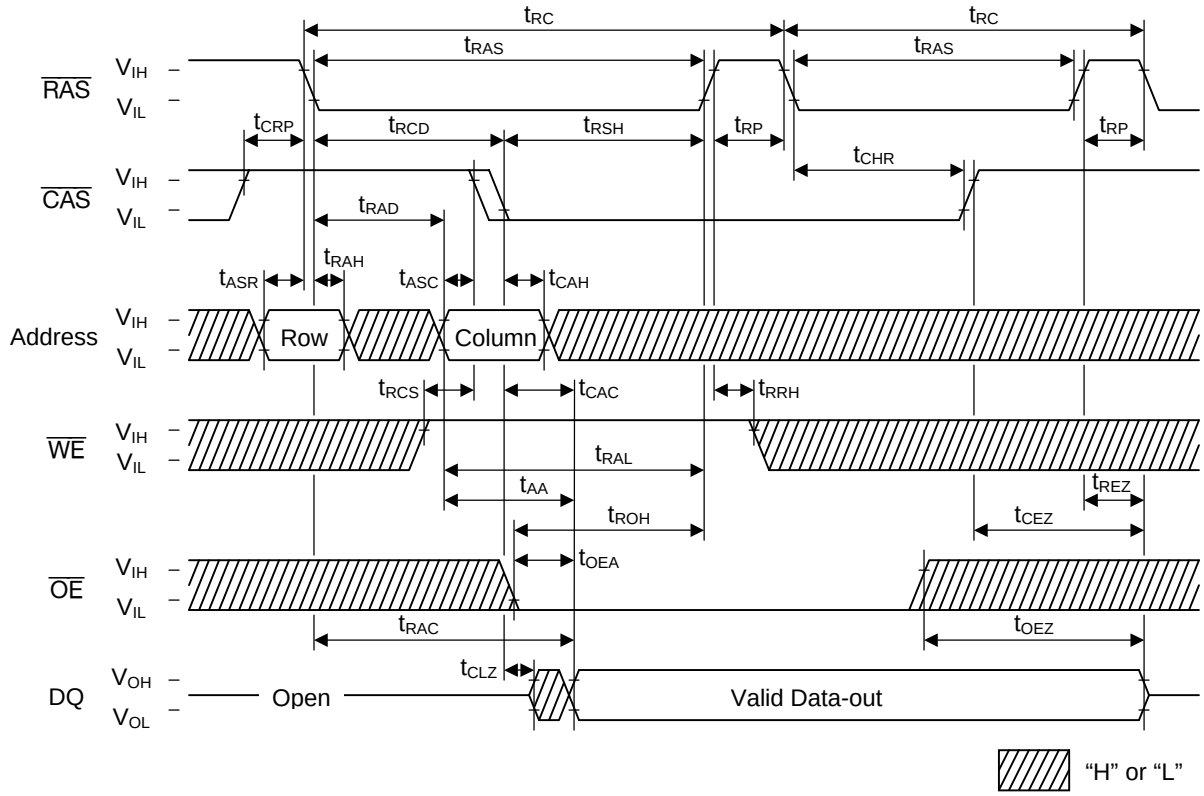
$\overline{RAS}$-only Refresh Cycle



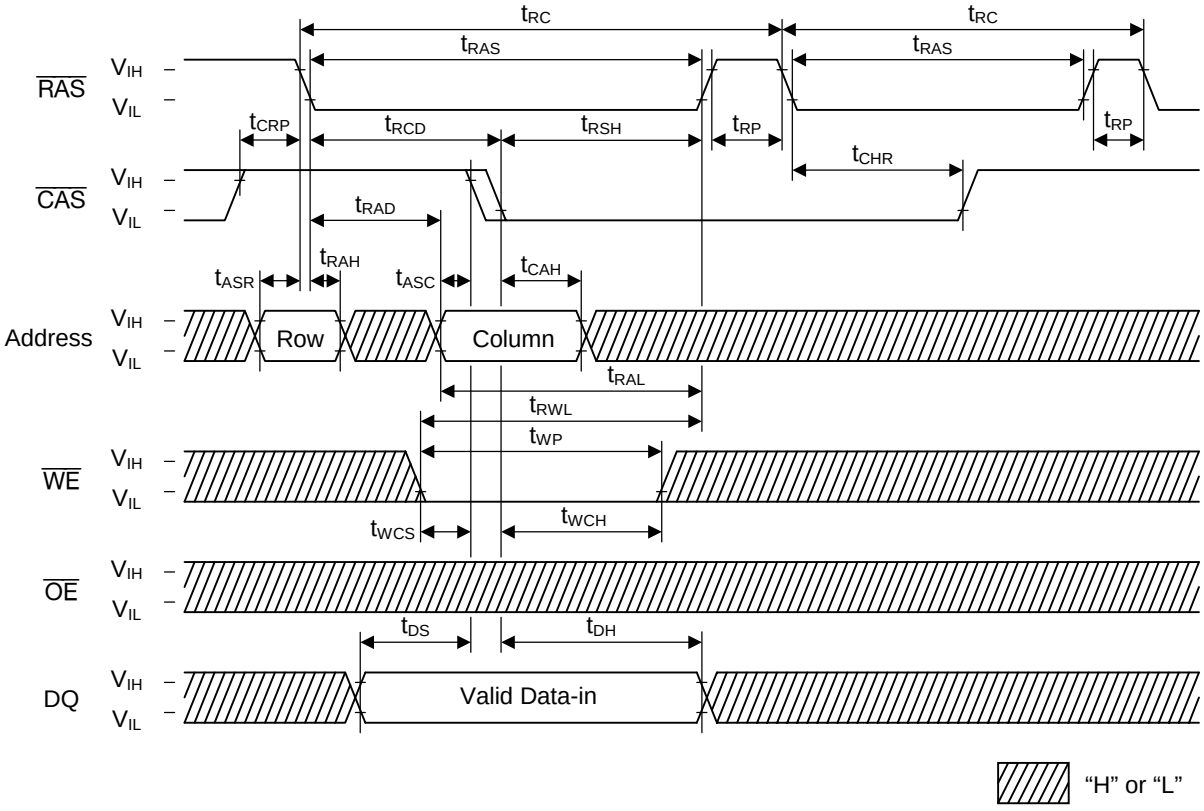
$\overline{CAS}$ before $\overline{RAS}$ Refresh Cycle



Hidden Refresh Read Cycle



Hidden Refresh Write Cycle



REVISION HISTORY

Document No.	Date	Page		Description
		Previous Edition	Current Edition	
FEDD51V16165F-01	Nov., 2000	–	–	Final edition 1
FEDD51V16165F-02	May., 2001	5	5	Changed Operating currest specifications
FEDD51V16165F-03	Aug., 2002	1, 2	1, 2	Deleted SOJ package

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1. The information contained herein can change without notice owing to product and/or technical improvements. Before using the product, please make sure that the information being referred to is up-to-date.

2. The outline of action and examples for application circuits described herein have been chosen as an explanation for the standard action and performance of the product. When planning to use the product, please ensure that the external conditions are reflected in the actual circuit, assembly, and program designs.

3. When designing your product, please use our product below the specified maximum ratings and within the specified operating ranges including, but not limited to, operating voltage, power dissipation, and operating temperature.

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   Such applications include, but are not limited to, traffic and automotive equipment, safety devices, aerospace equipment, nuclear power control, medical equipment, and life-support systems.

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